CONSTRUCTION CONTRACT

New York City
Department of
Environmental Protection
59-17 Junction Boulevard
Flushing, New York 11373

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Commissioner

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Assistant Commissioner
Agency Chief
Contracting Officer

Invitation for Bids for Furnishing all Labor and Material Necessary and Required for:

Contract(s): **KEN-EAST-2**

Description: **KENSICO-EASTVIEW CONNECTION**

KENSICO SITE PREPARATION

Volume 2 of 2
Contract Terms and Specifications
(with separate Bid Booklet)

April 2023

KENS-EAST-2

KENSICO-EASTVIEW CONNECTION KENSICO SITE PREPARATION

TABLE OF CONTENTS

CITY OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF ENGINEERING DESIGN AND CONSTRUCTION

VOLUME 1 OF 2

KENS-EAST-2

KENSICO-EASTVIEW CONNECTION KENSICO SITE PREPARATION

TABLE OF CONTENTS

KENS-EAST-2
KENSICO-EASTVIEW CONNECTION KENSICO SITE PREPARATION
TABLE OF CONTENTS

END OF TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required to furnish, install, and test all hangers, supporting devices, and appurtenances shown, specified or required for pipes, fittings, valves, and other in-line equipment, complete and operational.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete

B. Section 03 60 00 – Grouting

C. Section 05 05 13.01 – Galvanizing

D. Section 05 50 00 – Metal Fabrications

E. Section 09 91 00 – Painting

F. Section 23 07 19 – HVAC Piping Insulation

G. Section 23 21 13 – Hydronic Piping

H. Section 40 05 07 – Hangers and Supports for Process Piping

1.04 REFERENCES

A. The Manufacturers Standardization Society of the Valve and Fitting Industry:

1. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture.
2. MSS SP-59 – Short Radius Welding Fittings.
3. MSS SP-69 – Pipe Hangers and Supports – Selection and Application.
4. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
5. MSS SP-90 – Guidelines on Terminology for Pipe Hangers and Supports.

B. ASTM A 36 – Standard Specification for Carbon Structural Steel.

C. ASTM A 48 – Standard Specification for Gray Iron Castings.

D. ASTM A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM A 276 – Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

F. ASTM A283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.

G. ASTM A778 – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

H. ASME – B31.1 – Power Piping.

I. N.Y. Spec 32-P-6 – Pipe, Special Castings, Valve Box Castings: Cast-Iron.

J. Latest Edition of the New York State Building Code.

1.05 DESCRIPTION

1. See Specification Section 40 05 07 Part 1.05

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturer and Pipe Support Designer:

1. Pipe hangers, supports, and appurtenances shall be standard products of the manufacturer specified herein.

2. Each type of hanger and support shall be the product of a single manufacturer.

3. The pipe support designer shall have a minimum of five (5) years of experience in the design of pipe supports and shall show evidence of having completed at least five (5) substantially similar, successful pipe support projects of equal complexity as the systems specified.

a. The pipe support designer shall be a New York State Registered Professional Engineer.

B. Supply and Compatibility

1. All hangers and supports for piping included in this section shall be provided by the Contractor through a single, qualified pipe manufacturer.

2. The pipe and fittings shall be designed, fabricated, and installed in accordance with standards referenced herein.

C. Regulatory Requirements:

1. All hangers and supports shall conform to the applicable requirements of ASME B31.1, MSS SP-58, SP-59, SP-69 and SP-90, except as modified herein, and be of standard manufacture wherever possible, and best suited for the service required.

2. Unless otherwise approved, all hangers, supports and concrete inserts shall be listed with Underwriters' Laboratory, Inc

1.07 SUBMITTALS

A. Contractor shall submit the Shop Drawings for approval of the Engineer. Submittals shall include, but not be limited to:

1. Name and qualifications of the New York State registered professional engineer to design the hanger and support systems and prepare the associated signed and sealed shop drawing submittals.

2. Detailed Shop Drawings showing all hangers, supports, restraints and expansion joints for each piping system. Shop Drawings shall be at a minimum scale of 3/16-inch equals one foot and shall show location, installation, material, loads, forces, stresses and deflections of all hangers and supports, expansion joints, racks, frames, braces, guides, anchors and related ancillary support system components. Reaction forces imparted to structures to which hangers and supports are attached shall be shown. At a minimum, the detailed drawings shall include but not be limited to:
    a. Scaled details of the device with dimensions.
    b. A table of applied forces and moments.
    c. A complete bill of materials.
    d. An isometric showing the applied forces and moments.
    e. Detailed connections to existing structure.
    f. Shop and field welds.
    g. Drawings shall locate components with each component identified by catalog number and show drawing detail matching the marking number for cross referencing.
    h. Anchoring Devices: Design, size and space support anchoring devices, including anchor bolts, inserts and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
    i. Tabulation of each size and type line to be supported and the support type and spacing to be used for each.
3. All drawings with required design calculations, signed and sealed by a New York State registered professional engineer.
4. Design calculations, prepared, signed, and sealed by the New York State registered professional engineer for each type of hanger, support, attachment, restraint, and anchor including but not limited to the following:
    a. Pipe stress analysis for static, dynamic, continuous and occasional loading demonstrating satisfaction of design requirements. Analysis shall include but not be limited to all loads and forces on the hangers, supports, restraints, and their reaction forces including but not limited to expansion, contraction, load, thrust, and surge as well as all other design requirement load, movement forces and stressors identified in Part 1 of this specification section.

b. Calculations associated with the design requirements described within this specification section and as indicated in the reference standards listed in Part 1 of this specification section.

c. Calculations shall be provided for each type of hanger, support, brace, attachment, and anchor.

5. Manufacturer's catalogs and engineering data on all hangers and supports, including load ratings, materials, installation details, maintenance information on hangers and support systems.

6. Contractor shall submit certification stating that all pipes and appurtenances connected to equipment are supported such that the pipes impart no stress nor load on the equipment.

B. Each submittal shall include the following:

1. A unique identification number and revision level.

2. Professional Engineer's seal and signature of the New York State registered professional engineer who prepared the hangers and support systems design calculations, system design shop drawings and related submittal information

1.08 DELIVERY, STORAGE, AND HANDLING

A. Equipment and materials shall be delivered to the Site to ensure uninterrupted progress of the Work. Pipe hanger inserts which are to be embedded in cast-in-place concrete shall be delivered in ample time not to delay the Work.

B. Equipment and materials shall be stored to permit easy access for inspection and identification and shall be kept in covered storage off the ground, using pallets, platforms or other supports. They shall be protected from condensation, corrosion, and deterioration.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not used.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

1.11 DESIGN REQUIREMENTS

A. Design, size and locate hangers, pipe anchors, expansion joints, pipe guides, and support systems throughout the facilities, whether shown or not.

B. Contractor shall visit the Site, conduct measurements, and coordinate with existing conditions and other trades to determine the exact route of piping and placement of all required pipe hangers and supports.

C. Contractor shall provide hangers and supports of sufficient strength to maintain the pipelines and appurtenances in proper position and alignment under all operating conditions.

D. Contractor shall provide the services of a New York State Registered Professional Engineer to design the supports for all pipelines and appurtenances, for all weights, forces and applied pressures. In the design of hangers, supports and anchors, unless otherwise shown or specified, pipe pressures shall be the maximum test pressures specified for pipelines carrying gases and twice the maximum test pressures specified for pipelines carrying liquids. The pipe support designer shall have a minimum of 5-year experience in the design of pipe supports and have completed at least 5 successful pipe support projects of equal complexity as the systems specified.

E. Hangers and supports design shall include load and movement calculations. Analyze each system for all loads and forces on the hangers, supports and restraints and their reaction forces transmitted to the structure to which they are attached. As a minimum, the following loads shall be included in hangers and support design and pipe stress analysis:

1. Gravity force, including weight of pipeline, insulation and appurtenances, contents, etc.
2. Thermal expansion force developed by the restraint of free end displacement of the piping.
3. Hydrostatic forces developed by internal pressure during operation of the piping system.
4. Loading due to expansion joint reaction forces.
5. Wind, snow, and ice loads for all exterior, exposed piping in accordance with the New York State Building Code. Refer to the Structural Notes on the Drawings for site- and structure-specific design criteria.
6. Buoyancy up to the latest published FEMA 500-year flood plain plus 30-inches of water uplift pressure.
7. Pressure waves produced by sudden changes in fluid momentum commonly referred to as water hammer.
8. Safety valve thrust loads.
9. Design loads that are shown and/or specified shall be supplemented by the standard minimum loads described in the listed standard references section

in Part 1 of this specification section to the extent that the most stringent provisions are utilized in developing loads.

F. Supports, guides and anchors for flexible couplings and expansion joints shall be in accordance with the coupling and joint manufacturer's specification and the standards of the Expansion Joints Manufacturers Association.

G. Wherever possible, pipe supports shall be designed using manufacturer's standard catalog products.

H. Special support and hanger details may be required and shall be provided for instances where standard catalog supports are not applicable.

I. Hangers and Supports for piping systems subject to thermal expansion and contraction, or to similar movements imposed by other sources, shall be designed to provide flexibility, and a pipe stress analysis shall be provided.

J. Where resonance with imposed vibration and/or shock occurs during operation, suitable dampeners, restraints, anchors, etc., shall be added to remove those effects.

K. Existing Support Systems: In order for existing support systems to be accepted as supports for new work, the Contractor shall demonstrate via calculations that existing support systems are adequate for the additional load. Where the existing support system are not adequate for the additional load the Contractor shall strengthen and/or supplement the existing support systems to account for the additional load.

L. Hangers and supports shall conform to the requirements specified in the standard references identified in the references section of Part 1 of this specification section, including but not limited to ASME B31.1, MSS SP-58, and MSS SP-127. Hangers and supports shall be of standard manufacture wherever possible and shall be best suited for the service required.

M. Unless otherwise approved, all hangers, supports and concrete inserts shall be listed with Underwriters' Laboratory, Inc.

N. No attempt has been made to show all required pipe supports or expansion joints on the Drawings. The presence or absence of pipe supports and/or details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the Work at no increase to Contract cost.

O. Stressors in hangers, rods and brackets shall be in accordance with Table 2 of MSS-SP-58.

P. All hangers and supports shall conform to the applicable requirements of ASME B31.1, MSS SP-58, SP-59, SP-69 and SP-90, except as modified herein, and be of standard manufacture wherever possible, and best suited for the service required.

Q. General Requirements:

1. Pipe and appurtenances connected to equipment shall be supported in a manner to prevent any stress being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, certification shall be submitted stating that requirements have been complied with.
2. Where practicable, piping shall be run in groups and parallel to building walls. A minimum clearance of one inch shall be provided between pipe and other work.
3. Piping and pipe hangers shall be located a minimum of 8'-0" above finished floor along general corridor walk way paths and equipment aisles.
4. Piping, hangers, and supports shall not obstruct access to existing valves and equipment for servicing and operation.
5. Hangers or supports shall be provided at all locations where piping changes direction.
6. Hangers and supports shall be capable of adjustment after placement of piping.
7. The number of different types of hangers and supports provided shall be kept to a minimum.
8. Suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub or flanged end.
9. Vertical piping shall be supported at each floor and between floors by stays or braces to prevent rattling and vibration.
10. Hanger rods shall be straight and vertical.
11. Chain, wire, strap or perforated bar hangers shall not be used.
12. Hangers shall not be suspended from piping.
13. Contact between dissimilar metals shall be prevented by use of copper plated, rubber or vinyl coated hangers or supports.
14. Hangers and supports shall provide for expansion and contraction throughout the full operating temperature range.
15. Any required pipe supports, for which the supports called for in this Section are not applicable, shall be fabricated or constructed from standard stainless steel shapes, concrete and anchor hardware, and shall be subject to the approval of Engineer.
16. Where hanger or support spacing does not correspond with joist or rib spacing, structural steel channels shall be attached to joists or ribs, and the pipes suspended therefrom.

17. All points of adjustment for pipe and duct hanger rods shall be locked securely in place using double-nutting. Double-nutting means two nuts torqued directly against each other under each point of adjustment in addition to a third nut on top of the bracket. Damaging threads or tack welding as a method of locking adjustment is not permitted.

18. All threaded assemblies shall be double nutted or provided with pinned nuts. Alternately, tack welding of bolted assemblies may be acceptable unless provisions for vertical adjustment is required.

19. Except where otherwise shown or required, horizontally installed valves 6-inches and larger shall be supported on each side of the valve, by pipe hangers or supports.

20. At all flexible couplings, supports shall be placed on each side and as close to the coupling as possible. Supports shall be the guide type which prevent axial movement from resulting in pipe deflection and misalignment.

21. Supports, anchorage and guidance for grooved end pipe shall be in accordance with the applicable sections of these Specifications and the recommendations of the manufacturer. The hangers and support details shown on the drawings are supplementary to this specification and supplementary to the standard references listed in this specification. In the event of conflict between the drawings and the Specifications, the most stringent requirement shall dictate.

22. In the design of hangers, supports and anchors, unless otherwise specified, pipe pressures shall be the maximum test pressures specified for pipelines carrying gases and twice the maximum test pressures specified for pipelines carrying liquids.

23. Wherever practical, pipe supports shall be designed in general alignment with the pipe support assemblies shown on the drawings with any required modifications and enhancements necessary.

24. Support arrangements shall be coordinated to maintain access for operations personnel, maintenance personnel and for removal of equipment.

25. Hangers and supports shall be designed, furnished, and installed to provide the piping elevations shown on the drawings.

26. Hangers and supports shall be coordinated with equipment, valve, and instrument access requirements as recommended by the respective manufacturers and as shown on the drawings so as not to encroach upon operations and maintenance access ways and access areas.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. General:

1. See Specification Section 40 05 07 Part 2.02.A – Materials/Equipment, General

B. Materials:

1. See Specification Section 40 05 07 Part 2.02.D – Materials/Equipment, Materials

C. Baseplates for anchoring supports to the floor shall be Type 316 stainless steel.

D. Only new materials shall be provided.

E. Proprietary fiberglass reinforced plastic supports and hangers for use with small diameter chemical and thermoplastic pipe shall be as specified herein and approved by the Engineer.

F. Hangers and Supports shall be of the following types:

1. See Specification Section 40 05 07 Part 2.02.C – Materials / Equipment, Types

G. Hanger Sizing:

1. See Specification Section 40 05 07 Part 2.02.E – Materials/Equipment, Sizing

H. Concrete Inserts, Attachment Plates, and Clamps:

1. See Specification Section 40 05 07 Part 2.02.F – Materials/Equipment, Concrete Inserts, Attachment Plates, and Clamps

2.03 FABRICATION / ASSEMBLING / FINISHES

A. See Specification Section 40 05 07 Part 2.03 – Fabrication / Assembly / Finishes

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. See Specification Section 40 05 07 Part 2.04 – Source Quality Control / Shop Tests

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. The Contractor shall coordinate the Work such that all HVAC piping hangers, supports, and restraining systems shall be installed and secured prior to the testing or activation of the HVAC pipeline on which they are installed.

3.02 INSTALLATION

A. See Specification section 40 05 07 Part 3.02 – Installation,

3.03 FIELD TESTING / QUALITY CONTROL

A. Each pipe support system shall be tested in conjunction with the respective piping pressure test.

1. All pipe support and restraining systems shall be installed and secured prior to the testing or activation of the pipeline on which they are installed.

2. All pipe support systems shall be tested for compliance with the Contract Documents. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. Tests shall include cycling the piping system to duplicate operating conditions. If any part of the pipe support system proves to be defective or inadequate, as evidenced by vibration or excessive movement, it shall be repaired or augmented at no additional cost to the City.

3.04 STARTUP / DEMONSTRATION

A. Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. See Specification section 40 05 07 Part 3.05 – Adjusting / Protection / Cleanup

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 34 00 – HVAC Fans

B. Section 23 74 16 – Packaged, Rooftop Air-Conditioning Units

C. Section 23 81 29 – Variable-Refrigerant-Flow HVAC Systems

D. Section 23 82 39 – Unit Heaters

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Vibration isolation equipment bases.
13. Restrained isolation roof-curb rails

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product.
    a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
    b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
2. Shop Drawings:
    a. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
    b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

3. Delegated-Design Submittal: For each vibration isolation device.
    a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

B. Informational Submittals
1. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
2. Qualification Data: For testing agency.
3. Welding certificates.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mason Industries, Hauppauge, NY
B. Kinetics Noise Control, Dublin, OH
C. Korfund, Bloomingdale, NJ
D. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Elastomeric isolation pads
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Smooth pattern.
5. Load-bearing metal plates adhered to pads.

B. Elastomeric isolation mounts.

1. Description: Double-Deflection, Elastomeric Isolation Mounts
2. Mounting Plates:
    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

C. Restrained elastomeric isolation mounts.

1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Open-spring isolators.

1. Description: Freestanding, Laterally Stable, Open-Spring Isolators
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Housed-spring isolators.

1. Description: Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
7. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
8. Top housing with threaded mounting holes and internal leveling device.

F. Restrained-spring isolators.

1. Description: Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
3. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
4. Top plate with threaded mounting holes.
5. Internal leveling bolt that acts as blocking during installation.
6. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
7. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
8. Minimum Additional Travel: 50 percent of the required deflection at rated load.
9. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
10. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed-restrained-spring isolators.

1. Description: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
3. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

4. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

H. Pipe-riser resilient supports.

1. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene
2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

I. Resilient pipe guides.

1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene
2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

J. Elastomeric hangers.

1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

K. Spring hangers.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

L. Vibration isolation equipment bases.

1. Steel Rails: Factory-fabricated, welded, structural-steel rails.

   a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   b. Include supports for suction and discharge elbows for pumps.

   c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.

   d. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

   a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   b. Include supports for suction and discharge elbows for pumps.

   c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

d. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

3. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

a. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

b. Include supports for suction and discharge elbows for pumps.

c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

d. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

e. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

M. Restrained isolation roof-curb rails

1. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

2. Upper Frame: Upper frame shall provide continuous and captive support for equipment.

3. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

4. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

5. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Contractor shall correct unsatisfactory conditions at no additional cost to the City before proceeding with installation.

3.02 INSTALLATION

A. Vibration control device installation

1. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

B. Vibration isolation equipment bases installation

1. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish and install all components of the system for identification of piping and equipment. The system includes the placing of identification signs and direction-of-flow arrows on all visible HVAC related plant piping, the placing of nameplates on HVAC plant equipment and structures, and painting in color of all equipment and pipe, except stainless steel or aluminum surfaces, as shown on the Contractor's working drawings submitted under the related Specifications sections for equipment, piping and valves, and as required for a complete job. This Section includes the following mechanical identification materials and their installation.

B. The Contractor shall coordinate equipment numbering scheme and pipe labeling scheme including selection of colors used with the facility prior to issuing submittal.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

B.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 23 07 13 – Duct Insulation

C. Section 23 07 19 – Piping Insulation

D. Section 23 09 14 – Control Panels, Enclosures and Devices for HVAC

E. Section 23 21 13 – Hydronic Piping

F. Section 23 21 16 – Refrigerant Piping

G. Section 23 34 00 – HVAC Fans

H. Section 23 74 16 – Packaged Rooftop Air Conditioning Units

I. Section 23 81 29 – Variable Refrigerant Flow HVAC Systems

J. Section 23 82 39 – Unit Heaters

K. Section 23 83 43 – Infrared Radiant Heaters

L. Section 23 90 00 – Heating and Ventilating Units

1.04 REFERENCES

A. See Specification Section 40 05 97 Part 1.04 – Identification of Process Equipment

1.05 DESCRIPTION

A. This Section includes requirements for providing identification for HVAC piping and equipment in accordance with applicable standards and regulations.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of the standards organizations and regulatory agencies, below:

1. American Society of Mechanical Engineers (ASME).

B. Qualifications of Manufacturer:

1. The identification signage shall be standard equipment of the manufacturer.

C. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

D. Provide the specified items from firms regularly engaged in the manufacture of identification devices of types and sizes required, with at least five (5) years' experience in manufacturing signs.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

a. Product data

B. Product Data: For each type of product indicated.

C. Samples: For color, letter style, and graphic representation required for each identification material and device.

D. Equipment and Valve numbering scheme.

E. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation, and packing of the identification systems for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The product shall be handled in such a manner that they may be transported and unloaded without being deformed, or otherwise damaged.

2. The product shall be protected from dirt, water, chemical, and mechanical damage and shall be stored in a dry area. Do not installed damaged product. Remove damaged materials from the Project Site.

C. Equipment and materials shall be delivered to the Site to insure uninterrupted progress of the Work.

D. Equipment and materials shall be stored to permit easy access for inspection and identification.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair, and adjust the equipment provided under this Section, as per the requirements of the Contract Documents and/or as recommended by the manufacturer. In addition:

1. Furnish the following spare parts and accessories:

a. For every 20 pipe identification signs installed:

1) One (1) pair stainless steel mounting screws

2) One (1) pair stainless steel threaded brackets

3) One (1) pair fiber or plastic washers

4) One (1) pair stainless steel banding seals.

2. One (1) set banding tools and banding accessories

3. One (1) stainless steel banding strap, approximately 1000 ft.

4. One (1) complete nameplate mounting assembly for every twenty (20) nameplates installed.

5. One (1) stainless steel cable and splice for every twenty (20) valve identification tags.

B. Provide all spare parts and accessories suitably boxed and marked for storage and reordering.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All equipment and materials provided under this Section shall be covered by a ten (10) year manufacturer warranty, which shall commence upon Substantial Completion or Occupation or Use Prior to Completion, whichever comes first. In addition, the manufacturer shall guarantee the sign, in writing, against color fading, chipping, corroding or any other manufacturing defects.

1.11 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. Construct fiberglass reinforced plastic identification signs and nameplates of 70 mils thick fiberglass reinforced plastic conforming to ASTM D709.

B. Provide fiberglass reinforced plastic process with a blemish free, low gloss surface of superior permanence and durability in the colors selected. Provide each identification sign and nameplate in two colors and with the legend specified. Provide the backside of the sign in black or some other uniform color.

C. Provide lettering made by silk screening or other permanent embedment of subsurface printed graphics in the material so as to produce a clear, legible sign. Do not place lettering, symbols or markings containing the name of the manufacturer on the signs. The Contract number and the year of the Contract as given on the Contract Drawings may be placed in small lettering on the front of the sign, if approved by the Engineer.

D. Provide signs for piping and valve identification with two 3/8 inch diameter grommet-protected holes located on the long side center line, the center of the hole to be ½ inch from the edge. Provide nameplates for equipment and structures with four 3/8 inch diameter grommet-protected holes, the center of the hole located ½ inch away from the edges. Provide all holes with suitable brass or stainless steel grommets.

E. Construct all signs and nameplates in conformity with ASTM D523, D638, D646, D790, D792 and D5420.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Provide identification signs and nameplates rectangular in shape and of the dimensions specified below. A dimensioned tolerance of plus or minus 1/16 inch is permissible.

1. Type of sign:

a. Pipe Identification sign dimensions:

1) 4 inches and larger outside diameter of pipe (including pipe insulation): 3-1/2 inches x 12 inches.

2) Less than 4 inches: 1-1/2 inches x 7 inches.

b. Valve Identification:

1) Valve Tags: 2-inches diameter.

2) Operating stands for valves: 1-1/2 inches x 7 inches.

c. Nameplates:

1) Equipment and structures: 3-1/2 inches x 12 inches.

B. Lettering of Signs:

1. Perform all lettering and numbering on identification signs and nameplates in block style in size and spacing to suit the size of sign, as approved by the Engineer.

2. Unless otherwise approved, limit the legend on pipe identification signs to one line and to a total of 12 letters and spaces, and the legend on equipment nameplates to two lines and a maximum of 35 letters and spaces.

3. Submit samples of the lettering to be used for fiberglass reinforced plastic signs to the Engineer for approval before manufacturing begins. Such samples must show the height, width and spacing of letters and numbers for any three (3) legends of ten or more letters and spaces.

C. Chemical Resistance:

1. Provide fiberglass reinforced plastic signs resistant to abrasion, impact, corrosion, and the following acids, alkalis, salts and solvents in accordance with ASTM D543:

a. 10% citric acid

b. 5% acetic acid

c. 3-30% sulfuric acid

d. 10% ammonium hydroxide

e. 10% sodium chloride

f. turpentine

g. mineral spirits

h. heptane

i. kerosene

j. ethyl alcohol

k. ethyl acetate

l. transformer oil

m. heavy duty detergents

n. water

2. Submit certification on acid resistance to the Engineer prior to installation.

D. Colors:

1. Code pipeline signs and equipment nameplates and finish coats of paint for pipe lines and equipment in basic colors.

2. Provide brilliant colors, distinctive shades matching as closely as possible (without custom color blending) the following basic colors as specified by the Munsell Color System (MN):
   a. White: MN-N8.8/
   b. Yellow: MN – 4Y7.5/12.8
   c. Orange: MN – 0.5 YR 4.6/12.2
   d. Red: MN – 7R 3.6/12.7
   e. Brown: MN – 2.5 YR 4.2/4.3
   f. Gray: MN – 2.5PB 5.8/1.7
   g. Charcoal: MN – 6B 5/0.4 (provide color "Charcoal: for paints equivalent to MN – N 3.75).
   h. Black: MN – N1/
   i. Blue: MN – 3PB 3.3/7.4
   j. Green: MN – 8G 4.4/6.2
3. Provide identification signs for pipelines of all sizes, mechanical equipment and valves in the color combinations specified below:
   a. Heating, Ventilating and Air Conditioning (equipment, piping, and ductwork): Green letters, Charcoal background.

E. Legend for Pipe Identification Signs:

1. Provide identification signs with the following words or abbreviations in color combinations shown to identify the pipe-line service:

Pipe Identification Signs			
		Color Code	
Legend	Service	Lettering	Background
RL	Refrigerant Liquid	Black	Yellow
RG	Refrigerant Suction	Black	Yellow
CD	Condensate Drain	White	Green

2. Number valves in conformity with the Basic Code as specified by the Operation and Maintenance Manual for the plant. Perform color combinations for such lines and valves in the same color combinations as the medium serviced.

F. Valve Identification Tags:

1. Furnish and attach valve identification tags on all valves and controls.

2. Provide round fiberglass reinforced plastic discs tags, approximately 2 inches in diameter, made in conformity with the requirements of Article 2.01. Provide tags with one 1/8 inch grommet protected hole at the top for fastening to the valve body using 1/16 inch diameter cable and splices or pins as approved. Provide grommets, cable splices and pins of stainless steel or other approved corrosion resistant material.

3. Provide numbering code for the identification tags in conformity with the Basic Code as specified by the Operation and Maintenance Manual for the plant. Assign identification numbers subject to the approval of the Engineer and in conformity with the entire piping and equipment identification system. Provide identification code for each valve and control without duplication. Provide lettering on identification tags not less than 5/16 inch high and limited to two lines. Silk-screen lettering in correct color combination; stenciled or painted numbers and lettering will not be accepted.

G. Arrows:

1. Make direction-of-flow arrows for attachment to pipe identification signs from No. 16 U.S. gauge Type 304 stainless steel, the full width of the sign. Make the arrow head with a tapered point, about 90 degrees at the apex, extending one half of the sign width from the sign edge and one half of the sign width extending under the sign. Finish all edges of the arrow. Make point with a radius of 1/4 inch for the 3-1/2 inch wide sign and a radius of 3/16 inch for the 1-1/2 inch wide sign. Punch detents on the arrows to prevent twisting of the point. Drill one hole in the arrow in alignment with the hole in the pipe identification sign so that both sign and arrow can be mounted with the same screw and bracket.

2. Submit sample direction-of-flow arrows for both sizes of pipe identification signs to the Engineer for approval before installation.

H. Nameplates:

1. Provide nameplates for equipment and structures in the same color combination as the medium they service. Legends for nameplates must follow the terminology shown. Provide numbering system as described in the Operation and Maintenance Manual.

2. The following is a representative list, not necessarily complete, of nameplate legends with appropriate color combinations to which the equipment identification number must be added:

N A M E P L A T E S			
Legend		Color Code	
First Line (1)	Second Line (2)	Lettering	Background
AIR CONDITIONING	UNIT **	White	Charcoal

N A M E P L A T E S			
Legend		Color Code	
First Line (1)	Second Line (2)	Lettering	Background
BRANCH CIRCUIT	CONTROLLER**	White	Charcoal
ROOFTOP AC UNIT	**	White	Charcoal
HEAT PUMP	**	White	Charcoal
EXHAUST FAN	**	White	Charcoal
SUPPLY FAN	**	White	Charcoal
ELEC WALL HEATER	**	White	Charcoal
GRAVITY INTAKE	VENTILATOR **	White	Charcoal
DEHUMIDIFICATION	UNIT**	White	Charcoal
ELEC DUCT HEATER	**	White	Charcoal
ELEC UNIT HEATER	**	White	Charcoal
UNIT HEATER - HW	**	White	Charcoal

(1) Nominal limit of 18 letters, numerals, and spaces.
(2) Nominal limit of 17 letters, numerals, and spaces.
*Where equipment is mounted on roofs or where exposed to the public view, such as in lobby or office areas, the color will be selected by the Architect.

**The legend on these nameplates also includes the appropriate six-digit numeral and letter designation for such equipment and structures as specified by the Operation and Maintenance Manual.

I. Additional Signs and Nameplates:

1. In addition to the legends specified above, the Engineer may order the Contractor to furnish and install additional identification signs, arrows and nameplates at no additional cost to the City. Such additional signs may be requested near completion of the Work and will be limited to no more than five (5) signs for each type specified. Conform legends and color combinations for additional signs to the requirements specified.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not used

3.02 INSTALLATION

A. Locate identification signs for piping along straight line runs at intervals of not more than 30 feet, near valves, branches and junction points, where pipes pass through walls or ceilings, and where trench piping is accessed through removable covers. Place direction-of-flow arrows as shown or required. Locate signs on large valves on or adjacent to the valve itself. Place all piping identification signs so as to be easily visible from operating locations. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures so as to prevent damage to the nameplate.

B. Mount identification signs and arrows on piping parallel and tangent to the pipe and valves by fastening with screws, plastic or fiber washers, threaded brackets and banding straps and seals. Provide screws and brackets of stainless steel with 5/16 - 18 American Standard Coarse Threads; provide No. 25 U.S. gauge stainless steel, 3/4 inch wide bands.

C. Where pipe is insulated, use care in mounting the signs so to prevent the banding straps from crushing the insulation.

D. Provide mounting assembly "Steelbinder" strapping unit as manufactured by A.J. Gerrard & Co., Des Plaines, Illinois, Independent Metal Strap Co., Inc., Roslyn, N.Y. or approved equal.

E. Mount nameplates in a manner specifically approved by the Engineer after the installation of equipment or construction of structures. Submit details of the method of fastening to the Engineer for approval. Provide fastening devices for nameplates and valves of stainless steel construction.

F. Mount valve identification signs with approved stainless steel brackets or approved stainless steel strapping in such a fashion that sharp corners or edges on signs, brackets, bolts, chain or strapping will not constitute a hazard to personnel operating the valves. Since it is impractical to detail each means of attachment in the Specifications or on the Contract Drawings, each means of attachment will receive approval only on its own merits. Submit for approval sketches of each type proposed. The attention of the Contractor is directed to Articles 3 and 4 of the Agreement, and to Article 1 of the General Conditions under paragraph entitled "Conflicts."

1. Do not attach identification tags or signs to handwheels. Use of flange bolts or bonnet bolts as a means of attachment of brackets will receive consideration. Provide all attachment devices and bolting of Type 304 stainless steel.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not used.

3.04 STARTUP / DEMONSTRATION

A. Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning:

1. In addition to the requirements of the Contract Documents, the Contractor shall thoroughly clean all surfaces of the installed identification systems and remove all debris and waste materials resulting from installation.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform testing, adjusting and balancing of all Heating, Ventilation and Air Conditioning Systems as specified or required for proper operation.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. Reference Standards: Comply with applicable provisions and recommendations of the following except as shown or specified:

1. ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.), Systems Volume, Latest Edition.
    a. ASHRAE Standards 111, Practices for Measurement, Testing, Adjusting, and Balancing of Buildings Heating, Ventilation, Air-Conditioning and Refrigeration Systems
2. Test, adjust and balance systems in accord with:
    a. Associated Air Balance Council (AABC): (1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems (AABC-MN-1).
    b. National Environmental Balancing Bureau (NEBB): (1991) Procedural Standards for Testing Adjusting Balancing of Environmental Systems (NEBB-01).
    c. AABC "National Standards for Field Measurements, Total System Balance, Air Distribution, Hydronics Systems, Volume One Number 81266".

1.05 DESCRIPTION

A. Heating, ventilating, air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the test, adjust and balance work specified.

B. Reports shall be certified by the testing engineer that the methods used and the results achieved are as specified.

C. CORRECTIVE ADJUSTMENTS

1. Should corrective measures caused by faulty installation require retesting, adjusting and balancing, such work shall be performed at no additional expense to the City.
2. Inspections:
    a. Fan Belt Deflection: No less than 1/4-inch or more than a 1/2-inch.
    b. Finned Coils: Plate type fins shall be combed out with a fin comb for appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

1.06 QUALITY ASSURANCE

A. Balancers Qualifications:

1. Submit work experience or resume of proposed biographical data on employee who will directly supervise the Testing, Adjusting and Balancing Work.
2. Submit proof of certification by NEBB (National Environmental Balancing Bureau), AABC (Associated Air Balance Council), or SMACNA (Sheet Metal and Air Conditioning Contractors' National Association), or

demonstrate that the standards and experience required for certification are possessed, all to the satisfaction of the Engineer.

3. Submit a record of at least 5 years' experience in the testing and balancing contracting industry, engaged in heating, ventilating, and air conditioning work.

1.07 SUBMITTALS

Contractor shall submit Shop Drawings and material Specifications for the approval of the Engineer. Submittals shall include, but not be limited, to:

A. Data Sheets:

1. Submit samples of data sheets on each item of equipment for approval.
2. Submit data sheets on each item of testing equipment required.
3. Include name of device, manufacturer's name, model number, latest date of calibration, and correction factors.

B. Report Forms:

1. Submit specimen copies of report forms for Engineer's approval.
2. Forms shall be 8-1/2 by 11-inch paper for looseleaf binding, with blanks for listing of the required test ratings and for certification of report.
3. Reports shall be on the organizations approved forms imprinted with the company's name.
4. Certified report outlining procedure used to balance the system and the types of measuring devices used.

C. Test results shall be submitted on approved forms in a typed format.

D. Submit certified copies of required test reports to the Engineer for approval.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. INSTRUMENTS: GENERAL

1. Contractor shall provide all necessary instrumentation, tools, ladders, etc. to complete all air and hydronic balancing tests and adjustments.

2. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

3. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.

4. Contractor shall assume full responsibility for safe keeping of all instrumentation during the course of Work.

B. AIR BALANCE INSTRUMENTS

1. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, etc. as may be required to perform all air balance tests of HVAC equipment, ducts, registers, grilles, etc.

C. WATER BALANCE INSTRUMENTS

1. Provide manometers, pressure gages, and other instruments and accessories as required to balance the water system.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. SYSTEM PERFORMANCE MEASURING INSTRUMENTS

1. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete HVAC system performance.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All testing, adjusting, and balancing of air and hydronic systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with the Contractor. Contractor shall submit one copy of the standard procedure manual to the Engineer for his records.

B. Contractor shall be solely responsible for the protection and safeguarding of his Work and shall provide every protection against accidents, injury, and damage to persons and property.

C. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.

D. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.

E. Contractor shall install additional access panels at no extra cost to the City, as is required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.

F. Air systems shall be tested, adjusted, and balanced with clean filters.

G. Hydronic systems shall be tested, adjusted, and balanced with clean strainers.

H. INSPECTION

1. The Contractor shall conform to the requirements of this Contract Equipment Checks:

a. Verify proper overload heater sizes.

b. Verify function of safety and operating controls.

c. Verify proper operation of equipment.

d. Report on inspection, observation and checking procedures.

3.02 INSTALLATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. The Contractor shall be bound by this Section to test and adjust all systems and accessories covered under this Contract. The Contractor shall also comply with the requirements of testing as outlined in the individual sections. Furthermore, he shall operate and maintain these systems for certain periods of time as specified herein, and shall leave them in good working order. The Contractor shall provide all necessary equipment and labor for this work.

B. All piping systems shall be thoroughly cleaned by flushing with water, disinfected, and tested by the Contractor for tightness. Prior to testing all other piping systems, the Contractor shall submit a test procedure for each system to the Engineer for review. Pipe lines shall be flushed at a rate of at least 2.5 feet per second for a duration of minimum one hour. The units and control valves shall be isolated before flushing. The pipe line shall be flushed again after opening the valves at the units. In general, piping shall be tested hydrostatically at 1-1/2 times the maximum design pressure for which the system is intended, but not less than 100 psi. The line shall be filled with water for a period of not less than 6 hours, then subject to the indicated test pressure. Duration of test pressure shall be four (4) hours. During the pressure test there shall be no leakage. All air shall be purged from the line before pressure testing. Any leak shall be repaired in a manner acceptable to the Engineer and the system retested until all such piping shows tight.

C. Refrigerant piping must be tested before any piping is insulated or concealed. The entire refrigerant circuit must be thoroughly tested to be sure that it is absolutely tight. The system shall be tested with oil pumped, dry nitrogen. The low side of the system shall be tested at 150 psi and the high side at 300 psi. All pipe joints shall be tapped sharply with a rubber mallet and tested for leaks with a soap solution. After all leaks have been repaired, the system shall be charged with a small quantity of refrigerant and the entire system shall be checked with a halide leak detector. Once the system is found tight, it shall be allowed to stand for 6 hours with the pressure on. If any pressure drop occurs, except those due to changes in ambient temperature, the entire system shall be retested. The system shall be evacuated with a vacuum pump until vacuum of 2.5 mm Hg is achieved. Under no circumstances shall the compressor be used to evacuate the system. After evacuation, the system shall be allowed to stand for 12 hours. If no noticeable rise in pressure occurs, the system shall be charged.

D. All ductwork systems including air outlets shall be tested, adjusted and balanced for within limits of the required airflows as indicated on Drawings and specified in this Section.

E. After all final tests have been performed on all equipment and on all sub-systems installed under this Contract, including the testing of all controls specified in other Sections, and after the results from all such testing have been accepted, the Contractor shall test the overall system by demonstrating its ability to respond properly to normal changes in controlled parameters, as well as to system upsets. To facilitate this, he shall make available a minimum of two men, thoroughly familiar with the systems and equipment installed under this Contract, for a minimum of seven (7) Days to test the system by changing controlled parameters and generating system upsets as directed by the Engineer, and demonstrating that the sequential action appropriate to the particular change or upset occurs automatically. Where actual change or upset is not feasible, the Contractor shall simulate the change or the upset. Controlled parameter changes shall include, but not necessarily be limited to, any change in temperature, pressure, flow rate, fluid level, load, etc., which should result in an automatic change in the position of a control valve or control damper, in the output rate of a piece of equipment, in the normal start-up or shutdown of equipment, etc. The change in the state of the controlled device or equipment shall be shown to result in a corrective action on the controlled parameter. Upsets shall include, but not necessarily be limited to, any condition which should cause annunciation of an alarm, safety shutdown of equipment, startup of standby equipment, closing of fusible-link devices, lifting of relief valves, etc. The Contractor shall immediately restore to its original state any safety device, the state of which has been changed by its having been tested.

F. Contractor shall immediately correct any system deficiency that should come to light during testing.

G. After the overall system testing has been completed, and after all final adjustments have been made, the Contractor shall operate and maintain all new systems and equipment, Site-wide, associated therewith, for a period of thirty consecutive Days.

During this period all normal maintenance (filter replacements, strainer cleaning, periodic checks of safety devices, datalogging, etc.) shall be performed by the Contractor. If, during this period, any work beyond routine maintenance of equipment and materials installed under this Contract, should be required to maintain proper operation of the overall system, the elapsed time shall be forfeited, and a new thirty-day (30) period shall commence following the completion of the corrective action.

H. The Engineer will determine which fuel shall be burned in the boilers during these periods. All fuel and utilities required for system operation shall be provided by the City.

I. AUTOMATIC CONTROL SYSTEMS

1. In cooperation with the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

2. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by control system installer.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. BALANCING AND ADJUSTING

1. In addition to any other reference to balancing and adjusting specified elsewhere in these Section, the Contractor shall be bound by this portion of the Section to balance, adjust and leave in good working order all systems and accessories covered under this Contract.

2. The Contractor shall procure the services of an independent balancing and testing agency which specializes in the balancing and testing of heating, ventilating and air conditioning systems to balance, test and adjust all systems installed under this Section.

3. The Contractor shall advise the Engineer at least two weeks in advance of the date scheduled for balancing to commence; at the Engineer's discretion, the balancing shall be conducted in the Engineer's presence.

4. At least three (3) months prior to the commencement of balancing, the Contractor shall forward a detailed explanation of the balancing procedure to the Engineer for review. In general, the method shall conform to those specified by the Associated Air Balance Council or SMACNA.

5. All piping systems shall be balanced under this Section to provide the flows indicted on the Contract Drawings or in this Section.

6. Air systems shall be balanced before all hydronic and refrigerant systems.

7. Before beginning to balance the air systems the Contractor shall check, in the presence of the Engineer, all filters and coils for cleanliness, dampers (automatic, volume and fire) for correct position, all fans for proper rotation,

and temperature controls for minimum completeness to allow for proper balancing. If any of the above or other conditions are found which would not allow for proper balancing the Contractor shall take the necessary corrective actions, at his own expense, before balancing begins.

8. All heating, ventilating, and air conditioning systems shall be balanced by the Contractor by adjustment of dampers, fan sheaves, apparatus and air outlets to provide the air quantities indicated on the Contract Drawings. If necessary, adjustments of air outlets shall be made to eliminate drafts.

9. Balancing for all air systems shall be accomplished in a manner to first minimize throttling losses, then fan speed shall be adjusted to meet design conditions. All air outlets and fans shall be balanced within 5 percent of the design capacity.

10. Balancing for all hydronic systems shall be accomplished in a manner that results in the balancing valve which is hydraulically furthest from the pumps having a pressure drop of five feet at design flow, unless when wide open its pressure drops exceeds five feet, in which case, it shall be left wide open. (Inadequate pressure drop renders flow readings inaccurate; excessive pressure drop imposes needless additional head on the pumps). Balancing for the remainder of the system shall be accomplished in a manner to first minimize throttling losses. When variable speed drives are provided, pumps speed shall then be adjusted to meet design flow conditions. For each constant speed pump system having a pump motor greater than 10 HP, the following procedure shall then be followed:

    a. Record the pressure head across the pump, and the actual flow rate.

    b. For closed systems, multiply this pressure drop by the square of the ratio of the design flow to the actual flow. For open systems, include compensation for static head in performing this calculation.

11. Pump flows shall be balanced within 5 percent of the specified capacity.

12. After the systems have been balanced, the Contractor shall submit and certify to the City, a list containing the following minimum information for air outlets and equipment:

    a. Room or facility served.

    b. Size, quantity and model of air outlet or equipment.

    c. Type of air outlet or equipment.

    d. Air flow indicated on Contract Drawings.

    e. Air flow measured.

    f. GPM indicated on Contract Drawings.

    g. GPM measured.

    h. Entering and leaving water temperatures.

i. Fan cfm indicated on the Contract Drawings.

j. Fan cfm measured.

k. Fan motor running amps.

13. The Contractor shall advise the Engineer two Days in advance of the start-up of the heating and cooling water circulating systems. To be ready for start-up, the boilers, chillers, condensers and pumps and related equipment must be "off", and the system must be filled, purged, balanced and cool.

14. The Contractor shall record the following:

a. Pressure at system fill valve.

b. Pressure at pumps (inlet or outlet).

c. Pressure at building piping entries.

d. System temperature.

15. The Contractor shall start the pumps and record the following pressures:

a. System fill valve.

b. Pump inlets.

c. Pump outlets.

d. Building piping entries (supply and return).

16. The Contractor shall start heating and/or cooling equipment. Once system design temperature has been reached, and system is in equilibrium, again record the pressures listed above, as well as the temperatures at the inlets and outlets of the boilers, chillers, condensers, coils, and heat exchangers.

17. The Contractor shall submit all recorded data to Engineer for review.

18. The Contractor shall adjust any or all equipment which, in the City's opinion, is not set within acceptable limits of ±5 percent.

B. MARKING OF SETTING

1. Following approval of testing, adjusting and balancing (TAB) Verification Report, the setting of all HVAC adjustment devices including valves, and manual dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

C. IDENTIFICATION OF TEST PORTS

1. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leakage or to maintain integrity of vapor barrier.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required to furnish, install, and test all duct insulation complete and operational.

B. The following index of this Section is presented for convenience:

C.

D. The following schedules, attached after the end of section designation, are a part of this Section:

1. Schedule 23 07 13-1, Duct Insulation Schedule.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 40 05 97 – Identification for Process Equipment

1.04 REFERENCES

A. Reference Standards:

1. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers.
2. ASTM C449 Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
3. ASTM C534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C547 Mineral Fiber Pipe Insulation.
5. ASTM C552 Cellular Glass Thermal Insulation.
6. ASTM C553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
7. ASTM C612 Mineral Fiber Block and Board Thermal Insulation.
8. ASTM C647 Properties and Tests of Mastics and Coating Finishes for Thermal Insulation.
9. ASTM C916 Adhesives for Duct Thermal Insulation.
10. ASTM C920 Elastomeric Joint Sealants.
11. ASTM C1126 Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
12. ASTM E84 Surface Burning Characteristics of Building Materials.
13. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
14. NFPA 255 Surface Burning Characteristics of Building Materials.

1.05 DESCRIPTION

A. This Section includes requirements for providing duct insulation in accordance with applicable standards and regulations. In addition:

1. All fastenings, auxiliary equipment, accessories and appurtenances, necessary and/or required for a complete installation shall be included within the scope of Work.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the duct insulation installation.

2. Engage a firm which can show successful experience in the manufacture of duct insulation systems of scope and type similar to the required Work.

B. Contractor's Qualifications:

1. Contractor shall have at least five (5) years of experience in the installation of the Work specified. He shall employ only tradesmen with specific skills and experience in this type of Work.

2. Contractor shall have undivided responsibility as a single firm for performance and other requirements for the installation of the Work specified herein.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.

1. Underwriters Laboratories, Incorporated (UL).

2. National Fire Protection Association (NFPA).

3. Local and State Building Codes and Ordinances:

a. New York State Building Code

b. New York State Uniform Fire Prevention and Building Code

c. New York State Energy Conservation Construction Code

D. General: Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following Fire Hazard Classifications in accordance with ASTM E84:

1. Flame spread, 25 maximum.

2. Fuel contributed, 50 maximum.

3. Smoke developed, 50 maximum.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

a. Samples: Submit for approval samples of the following:

1) Thermal Insulation - Flexible.

2) Thermal Insulation - Rigid.

3) Acoustical Insulation.

b. Shop Drawings: Submit for approval manufacturer's catalog literature, Specifications, and illustrations with the following information:

a) Thermal properties

b) Physical properties

c) Fire hazard ratings

d) Facing information

e) Installation instructions

f) Jointing recommendations for butt joints and longitudinal seams

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Contractor shall provide spare parts and special tools necessary to service and repair provided under this Section, and as per the requirements of the Contract Documents.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All materials, equipment, and products provided under this Section shall be covered by a 10 year manufacturer warranty, which shall commence upon Substantial Completion or Use and Occupation Prior to Completion, whichever comes first.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Duct insulation:

1. Owens Corning, Toledo, OH.

2. CertainTeed Corp., Valley Forge, PA.

3. Schuller International, Inc. (Johns-Manville), Littleton, CO.

4. No. 814 –Spin-Glas, as manufactured by Johns-Manville, Littleton, CO.

5. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Exposed Ductwork Insulation (Rigid):

1. All exposed ductwork (as identified by Schedule 23 07 13-1, Duct Insulation Schedule, located after the End of Section designation), shall be insulated with minimum 1½-in. thick (except 2-in. thick for ducts located outdoor and outside air intake plenums) glass fiber board having a density of not less than 3.0 lbs./ft^3, and a thermal conductivity of not more than 0.23 BTU·in./(h·ft^2·°F) at 75°F mean temperature.
2. The exposed ductwork insulation shall be impaled over pins welded to the duct surface on 12-in. centers.
    a. The pins shall be coated with vapor barrier adhesive, and the insulation shall then be secured with caps over the pins.
3. All joints and breaks in the vapor barrier shall be sealed with 3-in. wide strips of the vapor barrier facing.
4. All insulation shall be reinforced with corner bead.
5. The facing shall be finished with a 3-ply application of lagging adhesive, glass fabric reinforcing and a finish coat of mastic.

B. Concealed Ductwork Insulation (Flexible):

1. All concealed ductwork (as identified by Schedule 23 07 13-1, Duct Insulation Schedule, located after the End of Section designation), shall be insulated with 1½in. thick flexible fiberglass duct insulation, having a thermal conductivity of not more than 0.28 BTU·in./(h·ft^2·°F) at 75°F mean temperature.
2. The insulation shall have a reinforced foil vapor barrier facing.
3. Insulation shall be secured with 4-in. wide bands of adhesive on 12-in. centers.
4. All joints shall be sealed by adhering a 2-in. sealing lap or 3-in. strips of vapor barrier facing applied with vapor barrier adhesive.
5. On horizontal ducts over 24-in. wide, welded pins and clips shall be used on the underside on 18-in. centers.

C. Internal Duct Liner Insulation - Acoustical Insulation:

1. Type: Fiberglass duct liner board with black surface.
2. Density: Minimum 1½ lbs. per cubic foot.
3. Thickness: 1½ in. minimum.
4. Thermal Conductivity: 0.23 Btu·in./(h·ft^2·°F) at 75°F mean temperature.

D. Adhesives and Accessories:

1. Acoustical Lining Insulation Adhesive:

a. Insulation shall be applied in cut-to-size pieces attached to the interior of the duct with a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

b. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire-resistant adhesive to prevent delamination of glass fibers.

2. Mineral Fiber Insulation Cement:

a. Cement shall be in accordance with ASTM C195.

3. Lagging Adhesive:

a. Lagging adhesives shall be nonflammable and fire-resistant and shall have flame spread and smoke developed ratings of 25/50 when measured in accordance with ASTM E84.

4. Contact Adhesive:

a. Adhesive may be dispersed in a non-halogenated organic solvent with a low flash point (flash pint less than minus 25°F when tested in accordance with ASTM D3278) or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200°F.

b. The adhesive shall be nonflammable and fire resistant.

5. Caulking:

a. Caulking shall be in accordance with ASTM C920.

6. Corner Angles:

a. Nominal 0.016 in. type 316 stainless steel 1-in. × 1-in. with factory applied kraft backing and adhesive.

7. Finishing Cement:

a. Mineral fiber hydraulic-setting thermal insulating cement ASTM C449.

8. Fibrous Glass Cloth and Glass Tape:

a. Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E84.

9. Staples shall be outward clinching Type 316 stainless steel.

10. White Vapor Retarder All Service Jacket (ASJ):

a. Shall be used on hot/cold pipes, ducts, or equipment.

b. Vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting.

11. Weatherproof Jackets:

a. Type 316 stainless steel jackets shall be smooth sheet, 0.016 in. nominal thickness.

b. Corrugated metal jacket shall not be used outdoors for insulated ducts.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Source Quality Control: Perform the following tests and inspections at factory.

1. Flame Spread

2. Smoke Developed

3. Fuel Contributed

B. Manufacturer's Markings:

1. Stamp or label with manufacturer's name and brand every package or standard container of covering, adhesive and coating delivered to the job Site for use.

2. Exposed side of insulation shall be legibly labeled by the manufacturer to show thickness, type and manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Contractor shall install all Work in complete accordance with the manufacturer's instructions and recommendations, and the approved Shop Drawings.

B. Sequencing: Obtain the Engineer's approval of insulation, adhesives, coatings and method of installation before installing any insulation.

C. All duct leaks shall be sealed prior to installation of external insulation to prevent billowing and damage to insulation.

D. Contractor shall ensure that all surfaces are clean and dry before applying insulation.

E. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

F. Contractor shall ensure that ductwork has been inspected and released for application of insulation

G. Contractor shall not install damaged insulation until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.

1. Only minor repair work will be permitted in the field.

2. All damaged insulation requiring remedial work shall be returned to the manufacturer for repair or replacement.

3.02 INSTALLATION

A. Install duct insulation in complete accordance with the manufacturer's printed instructions and the approved shop drawings.

B. Install insulation to make surfaces smooth, even and substantially flush with adjacent duct insulation.

C. Duct sizes indicated on Drawings are clear inside dimensions. Increase duct sizes to give designated inside dimensions when internal insulation is used.

D. Thickness of rigid insulation shall be greater than the seams or angles of ductwork to which it is applied.

E. Duct insulation shall be continuous through sleeves and prepared openings.

F. Insulation shall terminate at fire dampers and flexible connections.

G. Vapor barrier materials shall be applied to form a complete unbroken vapor seal over insulation.

H. Provide Type 316 stainless steel jacketing and waterproof sealants for insulated ducts exposed to outdoor.

I. Field Painting shall comply with the requirements of Section 09 91 00, Painting.

J. Identification markers and labels shall be in conformance with the Contract Documents and Section 40 05 97, Piping and Equipment Identification.

3.03 FIELD TESTING / QUALITY CONTROL

A. Furnish the services of a qualified manufacturer's representative to check and approve all insulation as well as conduct field testing, in accordance with the requirements of the Contract Documents. In addition:

1. Contractor shall verify that all Work furnished and installed conforms to the requirements the Contract Documents.

2. Reports: Submit a report from the manufacturer of each visit to the Site. Reports shall provide complete information on time, schedule, tasks performed, persons contacted, problems corrected, test results, instruction and all other pertinent information.

B. SCHEDULES

1. Thermal Insulation - Rigid: The following exposed ductwork exposed in room shall be insulated:

a. All outside air intake ducts and plenums from the outside air intake louver, outside air intake shaft, or roof mounted intake up to the point where the duct or plenum is connected to the heating and

ventilating units, air conditioning units, or supply fans in heated and air conditioned spaces.

b. All exhaust and return air ductwork from air conditioned spaces.

c. All supply and return air ductwork associated with Air Conditioning Units.

d. All heated and air conditioned ductwork located in unheated spaces.

e. All heated and air conditioned ductwork located outdoor shall be insulated and covered with weatherproof stainless steel jacket.

f. Where indicated on the Contract Drawings.

2. Thermal Insulation - Flexible: The following ductwork located above hung ceiling shall be insulated:

a. All supply, exhaust and return ductwork associated with air conditioning units.

b. All outside air intake ducts and plenums from the outside air intake louver, outside air intake shaft or roof mounted intake up to the point where the duct or plenum is connected to the heating and ventilating units and supply fans.

c. Where indicated on the Contract Drawings.

3. Acoustical Insulation: Ductwork shall be internally insulated as specified in the Contract Documents and where indicated on the Contract Drawings.

4. Insulation Thickness: All ductwork insulation shall be 1½-in. thick except for outside air intake plenum and outside air ductwork insulation which shall be 2-in. thick.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Remove all debris, waste materials and loose foreign matter resulting from installation.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 23 07 13 – Duct Insulation

C. Section 40 42 13 – Process Piping Insulation

1.04 REFERENCES

A. Referenced Standards:

1. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
2. ASTM C450 Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
3. ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C585 Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
5. ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
6. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
7. ASTM C871 Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
8. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
9. ASTM D1644 Standard Test Methods for Nonvolatile Content of Varnishes
10. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
11. ASTM E96 Standard Test Method for Water Vapor Transmission of Materials.
12. ASTM F1249 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
13. Building Code of the State of New York.
14. New York State Energy Conservation Code.

1.05 DESCRIPTION

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

b. Detail attachment and covering of heat tracing inside insulation.

c. Detail insulation application at pipe expansion joints for each type of insulation.

d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

e. Detail removable insulation at piping specialties.

f. Detail application of field-applied jackets.

g. Detail application at linkages of control devices.

B. Informational Submittals

1. Qualification Data: For qualified Installer.

2. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

3. Field quality-control reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Insulation Materials

1. Flexible Elastomeric Insulation:

a. K-Flex USA

b. Armacell LLC

c. Airex Manufacturing

d. Aeroflex USA

e. Or approved equal.

2. Polyisocyanurate Insulation:

a. Johns Manville, a Berkshire Hathaway company

b. Or approved equal.

B. Adhesives

1. Childers Brand

2. Foster Brand

3. Or approved equal.

C. Mastics

1. Childers Brand

2. Foster Brand

3. Knauf Insulation

4. Or approved equal.

D. Lagging Adhesives

1. Childers Brand

2. Foster Brand

3. Vimasco Corporation

4. Or approved equal.

E. Sealants

1. Polyisocyanurate Insulation:

a. Childers Brand
b. Foster Brand
c. Owens Corning
d. Or approved equal.

2. FSK and Metal Jacket Flashing:
a. Childers Brand
b. Foster Brand
c. Mon-Eco Industries, Inc.
d. Or approved equal.

F. Tapes
1. FSK Tape:
a. Knauf Insulation
b. Avery Dennison Corporation
c. 3M Industrial Adhesives and Tapes Division
d. Or approved equal.

G. Securements
1. Bands:
a. RPR Products, Inc.
b. Johns Manville; a Berkshire Hathaway company
c. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Insulation Materials
1. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.
2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

6. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

7. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

   a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 Days of aging.

   b. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84.

   c. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Adhesives

1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

3. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mastics

1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

2. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

   a. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

   b. Service Temperature Range: Minus 20 to plus 180 deg F.

   c. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

   d. Color: White.

3. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.

   b. Service Temperature Range: 0 to 180 deg F.

   c. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.

d. Color: White.

4. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F.
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
5. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F.
   c. Solids Content: 60 percent by volume and 66 percent by weight.
   d. Color: White.

D. Lagging Adhesives
1. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

E. Sealants
1. FSK and Metal Jacket Flashing Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F.
   d. Color: Aluminum.

F. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 1136, Type I, unless otherwise indicated.
2. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

3. Metal Jacket:
    a. Stainless-Steel Jacket: ASTM A 240/A 240M.
    b. Sheet and roll stock ready for shop or field sizing.
    c. Material, finish, and thickness are indicated in field-applied jacket schedules.
    d. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
    e. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    f. Factory-Fabricated Fitting Covers:
        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

G. Tapes
1. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
    a. Width: 3 inches.
    b. Thickness: 6.5 mils.
    c. Adhesion: 90 ounces force/inch in width.
    d. Elongation: 2 percent.
    e. Tensile Strength: 40 lbf/inch in width.
    f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

H. Securements
1. Bands:
    a. Stainless Steel: ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with closed seal.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Before insulating, apply a corrosion coating to insulated surfaces as follows:

C. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

D. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

E. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

F. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 INSTALLATION

A. General Installation Requirements

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    a. Install insulation continuously through hangers and around anchor attachments.
    b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
13. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
14. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
15. For above-ambient services, do not install insulation to the following:

a. Vibration-control devices.

b. Testing agency labels and stamps.

c. Nameplates and data plates.

d. Manholes.

e. Handholes.

f. Cleanouts.

B. Penetrations

1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

a. Seal penetrations with flashing sealant.

b. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

d. Seal jacket to roof flashing with flashing sealant.

2. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

a. Seal penetrations with flashing sealant.

b. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

d. Seal jacket to wall flashing with flashing sealant.

3. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

4. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

a. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

5. Insulation Installation at Floor Penetrations:
   a. Pipe: Install insulation continuously through floor penetrations.
   b. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

C. General Pipe Insulation Installation
1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
2. Insulation Installation on Fittings, Flanges, and Unions:
   a. Install insulation over fittings, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   b. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   c. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   d. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   e. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   f. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   g. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

4. Install removable insulation covers at locations indicated. Installation shall conform to the following:

   a. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

   b. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

   c. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

   d. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

D. Installation of Flexible Elastomeric Insulation

1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Insulation Installation on Pipe Flanges:

   a. Install pipe insulation to outer diameter of pipe flange.

   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

   d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install mitered sections of pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Installation of Polyisocyanurate Insulation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
   b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

F. Field-Applied Jacket Installation
1. Where FSK jackets are indicated, install as follows:
   a. Draw jacket material smooth and tight.
   b. Install lap or joint strips with same material as jacket.
   c. Secure jacket to insulation with manufacturer's recommended adhesive.

d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.

e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

2. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints

G. Finishes

1. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

2. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3. Do not field paint stainless-steel jackets.

H. Piping Insulation Schedule, General

1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

I. Indoor Piping Insulation Schedule

1. Condensate and Equipment Drain Water below 60 Deg F:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 inch thick.

2) Polyisocyanurate: 1 inch thick.

2. Refrigerant Suction and Hot-Gas Piping:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 inch thick.

2) Polyisocyanurate: 1 inch thick.

3. Refrigerant Suction and Hot-Gas Flexible Tubing:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 inch thick.

J. Outdoor, Aboveground Piping Insulation Schedule

1. Refrigerant Suction and Hot-Gas Piping:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 2 inches thick.

2) Polyisocyanurate: 2 inches thick.

2. Refrigerant Suction and Hot-Gas Flexible Tubing:

a. All Pipe Sizes: Insulation shall be one of the following:

1) Flexible Elastomeric: 2 inches thick.

K. Indoor, Field-Applied Jacket Schedule

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

2. If more than one material is listed, selection from materials listed is Contractor's option.

L. Outdoor, Field-Applied Jacket Schedule

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

2. If more than one material is listed, selection from materials listed is Contractor's option.

3. Piping, Concealed:

a. Stainless Steel, Type 316: 0.016 inch thick.

4. Piping, Exposed:

a. Stainless Steel, Type 316: 0.016 inch thick.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall employ the services of a Heating and Ventilating I&C Subcontractor who, acting through the Contractor shall, furnish, install, calibrate, test, tune, document and place in satisfactory operating condition the various local Heating and Ventilating Control Systems (HCS) as described herein. These systems shall include all control panels, instruments, controls, devices, interconnections, PLCs, etc., including those provided as part of packaged systems such as HVAC units, etc. For the purposes of these Specifications, unless otherwise noted, the term furnish shall be understood to include, selecting, sizing, furnishing and delivering all equipment, mounting appurtenances, software and services, preparing and submitting all required documentation, providing setup, testing, calibration, tuning, configuration and training services for all equipment provided. In addition, detailed installation and connection instructions and exact locations shall be provided. The term install shall be understood to include delivery to the area; mounting; electrical, process and mechanical connections; installation of supports; cleaning and protection of all equipment provided under this Contract. The responsibilities of the HVAC I&C Subcontractor, henceforth referred to as the HCS Supplier, shall also include but not be limited to, detailed system configuration and design, system integration, furnishing of all instruments and equipment, installation supervision, programming, supervision, calibration tuning, testing and training, as well as all required HCS, whether indicated or not. The Contractor shall provide the installation and connection (electrical, process and mechanical) of all equipment furnished herein.

B. The following index of this Section is presented for convenience:

C. Article Title

D. The scope of the equipment controlled by the HCS shall include all the space heating, cooling, ventilating, and air conditioning systems provided under this Contract.

E. The HCS supplier shall include all equipment, materials, supervision, labor, tools and documentation required to furnish, install, test and place in operation a complete and operable HVAC instrumentation, control and monitoring system as defined by the Contract Documents. While the scope of work for this Section shall include all Heating, Ventilating and Air Conditioning Contract Drawings and Specifications, the HCS supplier is specifically directed to information contained, equipment schedules, control and schematic drawings and Specification 23 09 00 through 23 09 93. The system shall include all measuring elements, instruments, controls, panels, signal converters, transmitters, local control panels, digital and analog hardware and software, PLCs, workstations, interconnecting conduit and wiring, control elements and such accessories as shown, specified, and/or required to provide the required functions and operability.

F. The Contractor shall review in detail the Contract Drawings and Specifications for the complete scope of work including mechanical process systems. Close coordination shall be provided.

G. It is the purpose and intent of these Specifications to construct a complete and working installation of top quality and reliability. Items of equipment or materials which may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

H. While the Contractor is responsible for all Work associated with the Project, the major responsibilities of the HCS Supplier shall include but not be limited to the following:

1. Furnish and supervise the installation of all HVAC systems, instrumentation, controls and system monitoring. Provide installation supervision, supports, hardware and appurtenances as required, scheduled and/or shown in the Contract Documents. Coordinate all aspects of

equipment and system monitoring and control with Contract requirements, mechanical equipment suppliers, other vendors and Subcontractors. Submit working drawings and shop drawings for all instruments, equipment, services and Work provided. Indicate, detail and supervise the location and installation of all process taps required for system implementation.

2. Supervise and direct the installation of all instrumentation and control equipment provided under this Contract.

3. Provide a detailed design for, assemble, test and furnish all control panels and enclosures as required, specified or shown on the Contract Drawings and Specifications. Local control panels shall be furnished and installed for all equipment provided under this Contract including but not limited to all, fans, heating and ventilating equipment, air conditioning systems, and all auxiliary equipment.

4. The HCS Supplier shall participate in the production of the Conduit and wiring diagrams required under this Contract. It shall review and approve all conduit, wiring and grounding system drawings pertaining to the HCS for proper routing, correct and adequate wire type and count, adequate conduit size and appropriate grounding. The HCS Supplier shall indicate by its approval that the conduit and wire systems are adequate and will permit him to install and operate the system as required.

5. Prepare detailed loop and point to point wiring diagrams for the entire HCS showing all instrumentation and control system terminations for, control, monitoring, signal, communication and ground wiring, all wiring and terminations between field instruments, equipment control panels, local control panels, PLCs and I/O, motor control centers and associated equipment as required. Wiring and terminations to panels and equipment provided by the HCS Supplier and those of all other HVAC equipment and devices provided by vendors and Contractors shall be shown and coordinated.

6. Provide installation supervision, calibration, testing, training, start-up and system tuning services for all instrumentation, control and monitoring equipment and systems associated with the HCS.

7. Furnish the installation and mounting hardware, brackets, stands, etc., necessary for all controls, instruments, etc., furnished under this Contract.

8. Furnish and direct the installation of all heating, ventilating and air conditioning instruments, controls, sensors, control panels, etc.

9. Furnish onsite training as specified for all equipment and services provided.

10. Furnish, supervise the installation and connection of, configure, test and place in operation, all local and remote I/O associated with the system in

local control stations, equipment panels, enclosures, motor control centers and as indicated or required.

11. Perform all field testing, tuning, startup and system optimization activities as required in the related section of this Division, and as specified herein.

12. Perform and participate in all startup, testing and tuning activities required for all equipment and systems provided under this Contract and as indicated in Specifications 23 09 15 – Instrumentation and Controls System Testing, Installation and Startup for HVAC, 23 05 93 – Testing, Adjusting and Balancing for HVAC.

I. The Contractor shall:

1. Retain the services of a duly licensed Electrical Subcontractor who, acting through the Contractor and under the direction of the HCS Supplier, shall provide a detailed design for, furnish and install all conduit, wiring and electrical system as required to implement the entire HCS, Conduit and wire shall be furnished and installed as required for all HVAC. The Electrical Subcontractor shall perform all electrical work required under this Contract including all required testing. The electrical system shall include but not be limited to, all equipment, controls, instruments, panels, conduit, raceways, wire, cables, junction boxes, terminal strips, enclosures, supports, hardware, accessories, grounding, etc. required to provide a complete installation. Power and control to damper actuators, etc. shall be provided herein. In most cases, power conduit runs to associated equipment and control panels shall be provided under the Electrical scope of work. Power and control conduit and wire for major equipment, from the MCC to that equipment, shall be provided where shown on the Electrical drawings. The Contractor shall furnish and install all conduit and wire from his control panels and equipment to all instrumentation, control devices, MCCs, control panels, actuators, etc. as required to implement the system. All electrical work provided under this Contract shall be in accordance with the requirements of Division 26, Specifications, Contract Drawings, the NEC and all applicable state and local codes. The electrical Subcontractor shall participate in all startup and testing activities required under this Contract.

2. Furnish, install, test and place in satisfactory operating condition a complete electrical system consisting of equipment, conduit, wire, raceways, etc. as indicated and as required to provide a complete and operational control and monitoring system for all HVAC equipment including heating, ventilating and air conditioning equipment, etc. provided under this Contract.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

C. Section 23 09 14 – Control Panels, Enclosures and Devices for HVAC

D. Section 23 09 93 - Sequence of Operation for HVAC and Specification

E. Section 23 34 00 – HVAC Fans

F. Section 23 74 16 – Packaged Rooftop Air Conditioning Units

G. Section 26 05 11 – General Electrical Requirements

H. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories

1.04 REFERENCES

A. Reference Standards:

1. AMCA Air Movement and Control Association Inc.

Standard 500 - Laboratory Methods for Testing Dampers for Rating

2. NFPA National Fire Protection Association

NFPA 70 - National Electrical Code

3. UL Underwriters' Laboratories, Inc.

UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations

B. In addition to the above-mentioned minimum standards, all requirements of; national, state and local codes and regulations; Bureau of Air Resources; Con Edison; DEP; Board of Standards and Appeals and all governing City, State and Federal agencies shall be complied with at no additional cost to the City.

1.05 DESCRIPTION

A. General requirements:

1. In order to centralize responsibility, all control and monitoring items (including field and panel instrumentation, control panels, PLCs, control system hardware and software, software development, etc.) provided under this Contract shall be furnished by the HCS supplier who, through the

Contractor, shall assume complete responsibility for proper installation and operation of the equipment, including that of coordinating all signals, furnishing all appurtenant equipment, and reviewing the conduit and wire system on the Electrical Drawings.

2. Where stated herein, the terms HCS supplier, System Supplier or HVAC I&C supplier shall be read as the Contractor.

3. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, location, installation, activation, checkout, testing, adjustment and proper operation of the entire instrumentation and control system. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local and central control panels, field instrumentation control systems and related equipment and/or systems and shall provide the services of a qualified installation engineer to supervise all activities required to place the complete instrumentation and control system in stable operation.

4. The Contract Drawings indicate the approximate locations of field instruments and control panels. The Contract Drawings (HVAC and Electrical) also indicate the routing of most major raceways and conduits to interconnect various areas within the building. The Contractor shall examine all the Electrical and Mechanical areas of the Contract Drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract.

5. Contract Drawing shows approximate size of panels. Actual panel sizes can vary from that shown as required to house specific equipment and/or to fit into the space available. The Contractor shall be responsible for the detail design of all panels and enclosures.

6. The terms "Instrumentation" or "Instrumentation and Controls" or "Control System" shall hereinafter be defined as all equipment, labor, services, documents, etc. necessary to meet the intent of the Specifications.

7. Damper or louver motor actuators shown on the Contract Drawings are diagrammatic and show only the requirement for motorized operation. The actual selection, quantity, capacity, layout, connection and sizing of the actuators, as well as linkages and mounting, required for the installation, shall be determined by the HCS Supplier based on the torque required to operate the damper system being provided. In all cases, the maximum torque required shall not exceed 80 percent of the actuator's capability. Larger dampers must be divided into sections. In these cases, multiple actuators are required and shall be furnished and installed complete with all required mounting, linkage, electrical connections, power, control and

disconnecting means. Damper end switches shall be connected to require all sections to open to prove open. The Engineer may allow the series/parallel connection of multiple actuators to provide indication from a majority of units. Dampers shall be configured as fail closed or open as directed by the Engineer.

B. Access:

1. The City shall have the right of access to the HCS Supplier's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and testing. Office space, supplies and services required for these surveillance activities shall be furnished by the HCS Supplier and the equipment suppliers.

C. Abbreviation:

1. To minimize the number of characters in words used in textual descriptions and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and/or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

D. Alternate Manufacturers:

1. If equipment manufactured by other than those mentioned in the Specifications is selected, the Contractor shall demonstrate that the selected equipment is functionally equal to the specified equipment, dimensionally compatible with space available and equal or superior in quality. The cost of any structural, mechanical, electrical, control, operating, maintenance or design changes necessary to accommodate such equipment shall be borne by the Contractor. Where model numbers for a particular item or equipment are mentioned, they are intended as a standard of quality and capability. It shall be the responsibility of the Contractor to verify items submitted meet the requirements of the Specifications.

E. Analog Signal Transmission:

1. Signal transmission between electric or electronic instruments, controllers and field equipment shall be isolated, linear 4 - 20 milliamperes and shall operate at 24 volts DC (nominal). Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Signals shall be linear with process variable to be measured and displayed. Signal corrections or conversions such as square root extraction shall be performed at the transmitter. All measurement loops shall be grounded at terminals bonded

to the panel ground bus and per the manufacturer's recommendations. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls and appurtenances. Signal isolation shall be provided when interfacing with existing equipment or with equipment supplied by other vendors.

2. Nonstandard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the instrument schedule. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated linear 4 20 milliampere signal proportional to the subject process variable.

F. Environmental Condition:

1. General:

a. Instrumentation equipment shall be suitable for ambient conditions indicated. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment. The HCS Supplier shall be responsible for providing a conditioned power supply for all electrical and electronic equipment furnished under this Contract needing such conditioning.

2. Control/Electrical Equipment Rooms:

a. The above rooms are air conditioned and heated; the temperature will normally be 20 to 25 degree C; relative humidity 40 to 75% without condensation and the air will be essentially free of corrosive contaminants and moisture during normal operation. During periods of abnormal operation, the temperature and humidity will be affected and can revert to outdoor ambient conditions. In addition, in the event of equipment failure, corrosive and contaminating agents will be present.

3. Field Locations:

a. Field equipment including instrumentation located outdoors will be subjected to wind, rain, snow, ice and corrosives in the environment, with ambient temperatures from -20 to 40 degree C and relative humidity from 40 to 100%. All supports, brackets and interconnecting hardware located outdoors shall be type 316 stainless steel. All field instruments mounted outdoors shall be furnished in the specified enclosure and subsequently mounted in thermal insulated field panels fitted with thermostatically controlled space heaters to suit the environment. Refer to Section 23 09 14 – Control Panels, Enclosures and Devices for HVAC for field panel requirements.

4. Process areas:

a. Instruments, control panels, etc. located in process areas such as the Screen Chamber, Injector Room, Fluoride Room, Raw Water Strainer Room, Water Quality Monitoring Room and mechanical equipment rooms, can become exposed to harsh environments with ambient temperatures from 0 to 40 degree C and relative humidity from 40 to 100%. Equipment in these areas shall be corrosion resistant. All mounting hardware supports and brackets shall be made of 316 stainless steel.

5. Electrical Power:

a. The electrical power at the Site is not guaranteed to be without surges, sags, spikes or noise. The Contractor shall provide common mode and normal mode noise reduction, surge suppressors and voltage regulation equipment such as power conditioners, filters, UPS, etc. to assure proper operation of the equipment. The plant power system can be supplied by on Site generators as well as utility power. Frequency swings of +/- 3 Hz and voltage variations of +/- 10% must be tolerated with no detrimental effects, or the equipment must be provided with additional power conditioning.

G.

1.06 QUALITY ASSURANCE

A. It is the purpose of these Contract Documents to secure high quality in all materials and equipment in order to facilitate operations and maintenance of the Plant. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection and during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner.

B. Electronic equipment shall be all solid state construction, utilizing semi-conductors, unless otherwise specified. Components shall be derated to assure dependability and long-term stability.

C. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers or digital controls. All parts shall be indicated in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

D. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of other equal manufacturers when they are favorably reviewed by the Engineer prior to installation.

1.07 SUBMITTALS

A. The Contractor shall submit shop drawings and material specifications for all equipment and Work provided, for the approval of the Engineer.

B. The following is a general listing of Working Drawing requirements for the HCS and associated equipment. When individual Specification Sections contain more specific requirements they shall be considered as additional to these minimum requirements. Components furnished as part of a packaged system shall comply with all requirements herein. All data submitted herein shall be updated to as built condition and appear in the final O&M manual. As a minimum, submittals shall include:

1. General (applies to all equipment and services supplied)
    a. Catalog cuts and data sheets.
    b. Installation and mounting details, methods and manuals with manufacturer's recommendations.
    c. Operation and users manuals.
    d. Reference manuals for hardware and software.
    e. Schematic wiring diagrams.
    f. Interconnection wiring diagrams.
    g. Location and mounting details.
    h. Space and power requirements.
    i. Enclosure / housing information.
    j. Materials of construction and finish data for all components.
    k. Bill of materials including quantities and model numbers.
    l. A list of spare parts and special tools.
    m. O&M manual.
    n. A listing of available and provided options and features.
2. Field and panel instruments:
    a. Completed ISA data sheets including manufacturer's name, model number, instrument tag number and serial number.
    b. Sizing, orientation and location calculations.
    c. Description of construction features.
    d. Performance, configuration and operational data.
    e. Service and maintenance requirements.
    f. Range, size and graduations.

g. Instrument or control device sizing and location calculations, where applicable.

h. Configuration data for all programmable instruments.

3. Control panels and control room:

a. Front, rear, top, bottom and side views showing access panels and all external features.

b. Assembly drawings.

c. Front panel instrument layout, legends, name plates and annunciator engraving listing.

d. Panel sections showing the location of all back of panel mounted instruments, power supplies fuses, relays, PLCs, terminal blocks, etc.

e. Power and grounding requirements, electrical schematics, point to point internal panel wiring and terminal block arrangement and numbering.

f. Contact development diagrams for all instruments, controls, relays and switches.

g. Ventilation / cooling methods and heat rejection calculations.

h. Color samples for panels.

i. Control room equipment layout and interconnection diagrams.

j. Conduit entry diagram.

k. Working drawings for all included equipment.

4. Programmable logic controller drawings.

a. Complete, well-annotated ladder logic and I/O listing.

b. Cross reference and variable tables and listing within ladder.

c. Physical rack and equipment layout drawings.

d. Communication and network diagrams and addressing schemes.

e. Hardware and software user, maintenance and installation manuals.

5. Electrical equipment, conduit and wiring layout drawings.

6. Factory and field test procedures, sample reports and certified reports.

C. Drawings:

1. Shop Drawings:

a. The HVAC drawings, electrical drawings, approved equipment shop drawings and instrument installation details shall govern the detailed layout of the completed construction.

1) Locations of field instruments are approximate. The Contractor shall be responsible for field verification, final placement and orientation of instruments to assure optimum performance, proper connection to the process and the instrumentation and control system and unrestricted access for maintenance and observation.

2) Not all field instruments are located on the Contract Drawings. Contractor shall follow the general guidelines established in the specification and best standard industry practice to determine the location of such instruments.

2. As-Built Drawings:

a. The Contractor shall maintain a complete and accurate record set of Drawings for the instrumentation and control system construction work. All Work shall be recorded.

D. Catalog Cuts:

1. The Contractor shall submit for review and approval; the name of the manufacturer; identifying trade name and/or model designation; data sheets; instruction, operation and maintenance manuals and catalog cuts for all equipment, material and software provided under this Division. Catalog cuts shall be certified for the tag numbers and ratings of the equipment being supplied. The model selected and all options selected shall be highlighted. The Contract tag numbers for all typical units shall be included in the submittal.

E. Electrical equipment, conduit, wiring, etc. submittals

1. Submit complete conduit and wiring layout drawings associated with the HCS. Submit Shop Drawings for all electrical work and materials in accordance with Section 26 05 11 – General Electrical Requirements, Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

F. Configuration Data Sheets:

1. For all PLCs, I/O blocks and programmable and/or “smart” programmable instruments, complete configuration data shall be submitted. All configuration and programming shall also be provided in appropriate storage platform. Configuration software shall be used to develop when available.

G. Documentation:

1. If any documentation or other technical information submitted is considered proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary shall be provided and will be used only for the construction, operation, or maintenance of the system and, to the extent permitted by law, will not be published or otherwise disclosed.

    a. Operating and Maintenance Manuals.

        1) The Contractor shall submit operations and maintenance manuals in accordance with the procedures and requirements set forth in Specification Section 01 78 25 – Operations and Maintenance Manuals.

        2) Preliminary O&M manuals shall be included in the shop drawing submittal. Without inclusion of these manuals, the submittal will be considered incomplete and will be returned without review.

        3) Original manufacturer's manuals and drawings shall be provided for all equipment and services provided under this Contract. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, loop diagrams and instructions necessary for installing, operating and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data and full preventative maintenance schedules.

        4) The instructions shall be bound in binders with drawings reduced or folded for inclusion and shall provide at least the following as a minimum:

            a) A comprehensive index.

b) A complete "As-built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

c) A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

d) Full Specifications on each item.

e) Detailed service, maintenance and operation instructions for each item supplied.

f) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

g) The operating instructions shall also incorporate a functional description of the entire system, with references to drawings and instructions.

h) Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

i) The operating manual shall be bound in one or more separate volumes from the maintenance manual and shall include detailed instructions which clearly describe the step-by-step procedures which must be followed to implement all phases of all operating modes. The contents of this manual shall be in terms understandable and usable by operating personnel. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

j) The maintenance manual shall be bound in one or more separate volumes and shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. Within the complete Hardware Maintenance Documentation, all hardware maintenance manuals shall make reference to appropriate diagnostics, where applicable, and all necessary timing diagrams, component drawings and PCB schematic drawings shall be included.

k) The Hardware Maintenance Documentation shall include, as a minimum, the following information:

(1) Operation Information. This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

(2) Preventive Maintenance Instructions. These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

(3) Corrective Maintenance Instructions. These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

(4) Parts Information – This information shall include the identification of each replaceable or field-repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between equipment numbers and manufacturer's part numbers shall be provided.

b. Application Software for PLC:

1) The Contractor shall provide 5 copies of a software documentation book which contains programs developed for this Project with extensive annotation of all logic.

2) All information associated with each application software program shall be assembled into a program description which will contain a detailed text that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This

descriptive text shall be written in a language that is understandable by non-software oriented readers.

H. Qualification Submittal:

1. The Contractor's HCS Supplier shall comply with all requirements stated herein.

2. The HCS Supplier shall be a qualified contractor having 5 years experience in providing DDC based major HVAC control and monitoring systems. The Contractor shall submit a detailed statement of recent experience in the completion of instrumentation, control, and information systems similar in type, size and complexity to that proposed for this Project. The statement shall include his last five projects completed to demonstrate the necessary experience required to perform work for the Project.

3. No later than 20 Days after notification to proceed, the Contractor shall submit to the Engineer the following information for approval of the HCS Supplier:

   a. General performance history of the prospective HCS Supplier, including:

      1) Wastewater treatment plant experience.

      2) Last five projects completed as additional proof of the necessary experience required.

      3) Detailed statement of recent experience in the completion of instrumentation, control and information systems similar in type, size and complexity to that proposed for this Project.

         a) The statement of experience shall provide a detailed description of each above referenced system including:

            (1) Name and address of owners and their representative(s).

            (2) Block diagram.

            (3) Functional description.

            (4) Project location.

            (5) Date of installation.

            (6) Date placed in operation.

4. A clear statement describing any and all deviations from the system specified herein, together with reasons for said deviations.

5. Resumes of proposed project engineer, project manager and field engineers.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Special care shall be exercised during delivery, distribution and storage of the materials to prevent damage. As a minimum, all equipment shall be stored per the manufacturer's recommendations. Damaged or incorrectly stored materials will be rejected and shall be replaced at the Contractor's expense. The storage area shall be ventilated and temperature controlled and the air shall be filtered and free of corrosive contaminants and moisture

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools for all equipment supplied, in accordance with Section 01 78 24 – Spare Parts and Maintenance Materials, and as detailed herein. Deliver all spare parts, tools and supplies with the equipment, neatly wrapped and boxed, indexed and tagged with complete information on their use and reordering.

B. The Contractor shall provide an inventory of spare parts for all control and instrumentation equipment provided as recommended by the manufacturer, as indicated below and in accordance with the individual Specifications.

C. Expendable Spares:

1. The Contractor shall provide expendable spares as needed or as required by the City during startup and testing and the specified warranty period. Expendable spares include items such as recorder and printer paper, fuses, ink, ribbon, lamps, etc. Expendable and non-expendable spares used during startup, testing and/or the warranty period shall be replaced by the Contractor. Based on the quantities used during the startup and warranty period, a one-year supply of all items shall be furnished at the end of the Contract.

D. Non-Expendable Spares:

1. As a minimum, the Contractor shall provide the following non-expendable spare parts. All equipment shall be burned in, tested and ready for use. These quantities are minimums, when more stringent requirements are made in other Sections, they shall supersede those indicated herein.

a. 10% (minimum of 1) circuit boards or modules of each type used in electronic field and/or panel instrumentation.

b. 10% (minimum of 1) instruments, devices and elements of each type.

c. 10% (minimum 2) of each type and rating of circuit boards (or modules) (I/O modules communication modules, network equipment, power supply module, etc.) used in the PLC system.

d. 10% (minimum of 2) adapters, converters, etc used in PLC and instrumentation systems.

e. 10% (minimum of 2) CPU and rack for each type used in PLC equipment.

f. Additional spare parts as recommended by manufacturer for each instrument.

g. 10% (minimum of 10) pilot, graphic and annunciator light bulb/led of each type.

h. 10% (minimum of 10) spare fuses of each type and rating provided.

i. All non-expendable spares consumed during installation, testing, start-up and the warranty period, shall be replaced by the Contractor prior to Final Acceptance of the system by the City. A list of spare parts for each instrument shall be submitted with the shop drawing for that instrument.

E. Special Tools:

1. Special tools, test equipment and software shall be provided for testing, checking, calibrating, configuring, programming, trouble shooting and repair of all equipment and services provided under this Section. All equipment provided herein shall be supplied with items such as instruction and operating manuals, manufacturers standard carrying/storage cases, unit battery charger and spare battery. Special tools, calibration fixtures, cord extenders, patch cords, power supplies, test leads, etc. as necessary, shall be provided for all equipment provided herein. All meters, test and calibration equipment shall be furnished with an NIST Traceable certificate of calibration. Certification shall be no more than 6 months old when equipment is turned over to the City.

2. The Contractor shall provide factory authorized training for DEP personnel on all special tools and test equipment and software provided.

3. As a minimum, the Contractor shall provide the following special tools:

a. Dry block calibrator capable of ambient up to 1100 degrees F with inserts for 1/8 inch -1/2 inch thermal sensors and NIST certificate, JOFRA Model 4070T, or approved equal.

b. Beta temperature calibrator Model 4610T, or approved equal, with pressure modules to simulate and measure 0 – 100 inch W.C. and 0 – 300 psig.

c. Two Fluke 87 III true RMS multi meters with 200 amp AC/DC current probes and hard cases, or approved equal.

d. Portable Calibrators:

1) Portable calibrators shall be capable of measuring DC volts, mV, mA, ohms, frequency, T/C, peak detect and trip detect

on its input and simultaneously generate on its output all of the preceding signals plus two-wire simulation, ramp functions, up/down stepping and 10 point programmability. Each calibrator shall be furnished complete with 24 Vdc integral battery pack 120 VAC power adapter, spare battery pack, test leads, external charger, fuse pack, carrying case and appurtenances. Basic accuracy for DC voltages and currents shall be +/- 0.025%; Resistance: +/- 0.035% for input and +/- 0.05% for output; Frequency: +/- 0.01%. Two portable calibrators shall be furnished. NIST traceable Certificates of Calibration shall be furnished for all calibrators. Calibrators shall be Rochester Instrument System AccuPro Diamond Plus, BETA, Transmation, or approved equal.

e. Portable Gauge and Differential Pressure Calibrator

1) Furnish one portable microprocessor-based, with 8K of memory gage and differential pressure calibration system. The calibration system shall include the following items: integral 115 VAC/DC battery power supply with charger, battery indicator and two sets of NI-CAD batteries 2; pump modules (0-100 psig max air type and 0-500 psi max hydraulic type psi max) with coarse and fine adjustment; and four pressure modules (0-10 inches W.C., 0-30 psi, 0-100 psi, 0-300 psi). All accessories, including manuals, tubing connectors and appurtenances shall be furnished for the unit, complete with weather resistant carrying case. Calibration systems shall be BETA Model 320 (Dual Sensor) as manufactured by BETA Products or approved equal.

f. Oscilloscope

1) One Electronic Oscilloscope with utility cart for field use equal to Tektronix type 465 with dual trace and rechargeable batteries or Hewlett-Packard Co. Model 1222A, or approved equal.

2) A utility cart shall be provided constructed of rugged structural foam and include two shelves each with 150 lbs capacity, 4 swivel casters with 4 inch wheels. Cart shall be as manufactured by JENSEN Model 997B001, or approved equal.

g. Hand Tools

1) A complete set of standard hand tools shall be furnished with the equipment. The set shall include approximately 100

tools and shall be supplied in a durable aluminum case. The tool kit shall be model JTK-17A by Jensen Tool of Phoenix, AZ, or approved equal.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Identification:

1. The system described below applies to all instruments and controls provided for this Project. Instruments not shown on the Contract Drawings but supplied by the Contractor to meet the functional requirements will be tagged as follows.

2. Instrument symbols and letter designations shall generally be in accordance with ISA Standard ISA-S5.1.

3. Instrument numbering shall be as follows:

a. Example: XXXX-YYY-FIT-###

1) XXXX - Building or Area Code Number

2) YYY - Equipment or Panel Number

3) FT - Instrument Designation (ISA)

4) ### - Sequential Process Loop Number

4. Instruments furnished as part of mechanical equipment and package units shall be identified and tagged with a unique number in the same manner under this Section. Tag names shall be submitted for approval. All the drawings and manuals pertaining to an instrument shall carry the full instrument identification tag number.

B. Nameplates:

1. All equipment, instruments, controls, panels, enclosures, network hardware, workstations, etc., shall be identified with nameplates. Equipment Tag names are for construction purposes. A list of final Tag names shall be provided by the City for final identification purposes and engraving. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number, full tag numbers and description of the item and function. Network node identifiers and applicable addresses shall be included for all computer based equipment. Abbreviations of the description and function shall be subject to the Engineer's approval. The Contractor shall furnish and install an additional one-hundred nameplates of the applicable type, 3 inch by 8 inch with three lines of 3/8 inch engravings per the Engineers instructions.

2. Temporary printed and laminated tags shall be affixed to all equipment until permanent tags are installed.

3. Nameplates shall be made of 1/16 inch thick machine engraved laminated phenolic plastic having black characters not less than ¼ inch high on a white background. Minimum size for name plates shall be 1 inch x 3 inches. All field mounted instruments shall also have SS name plates, which shall indicate the Contract tag number and service for that instrument. Additionally, each instrument shall have an engraved nameplate mounted adjacent to it indicating tag number, system, subsystem, manufacturer, range, setpoint, etc. All control panels and enclosures shall have nameplates with the equipment identifier and pertinent data. A second tag light blue with ¼ inch white lettering shall indicate network name and addresses and node names, etc. Engravings shall be submitted for review and approval.

4. Nameplates shall be attached to metal equipment by SS screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled (where applicable) and attached to the associated device by means of a braided stainless steel lanyard.

C. Finishes:

1. All instrumentation and control system materials and equipment which do not require a corrosion resistant finish or do not have an approved factory coating, shall be factory painted in accordance with Section 09 91 00 – Painting. All paint finishes shall include proper surface preparation, prime coat and a final finish coat. Any final finish which has been damaged or is otherwise unsatisfactory shall be repaired and be in good condition at the time of Final Acceptance.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. All equipment provided under this Contract shall be of the highest quality, state of the art, currently manufactured equipment offered as standard production items by nationally recognized and reliable firms. Untested or custom, one of a kind or experimental items or services shall not be permitted. Equipment provided under this Contract shall be heavy duty, industrial quality and designed for use in harsh industrial environments.

B. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Field-mounted devices shall be rugged and securely mounted on walls or pipe stands or as indicated in the Contract Documents.

C. All printed circuit boards utilized in instruments shall be cleaned, baked and coated with polyurethane or polyethylene conformal, or epoxy coating to immunize against effects of moisture, vibration and corrosive agents.

D. Panel-mounted devices shall be heavy duty oil tight type 30.5 mm with a rating equal to or greater than that of the enclosure.

E. All equipment provided under this Contract shall return to accurate measurement and operational condition upon restoration of power after a power failure or momentary interruption.

F. During periods of utility power outages, the Site will be powered by on-site emergency generators. Additionally, frequent plant load testing of emergency generators will be performed. At these times, equipment provided under this Contract will be powered by the generators. Voltage dips and spikes as well as frequency variations are to be expected during these periods. All equipment provided herein shall be capable of operation on emergency generator systems. The Contractor shall provide appropriate power conditioning for any equipment found to experience problems associated with the generated power.

G. The use of any device, instrument, equipment, etc. containing mercury shall be prohibited.

H. Power Supplies and Circuit Protection:

1. All equipment, instruments and devices provided under this Contract, requiring electrical power, shall operate on a nominal 120 Vac or 24 Vdc as indicated. 120 Vac power feeds for all instrument and control equipment

shall be provided under Section 26 05 11 – General Electrical Requirements, Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

2. Alternating current power supplies to panel mounted equipment shall be through a main circuit breaker and branch breakers or fuses located inside the panel. All 24 Vdc transmitters shall be powered from power supplies within the panel. Power supplies shall be redundant using a voting system or blocking diodes for isolation. Alarms shall be provided for each supply bus. All 24-volt instrument, signal and control circuits shall be individually protected by draw-out fuses, located in the panel.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. All equipment shall be installed per the Contract Documents, manufacturer's recommendations and standard industry practice. When installation methods are not shown or specified, the manufacturer's recommendations shall be used after review and approval by the Engineer. All mounting and supporting hardware and appurtenances shall be furnished and installed under this Contract.

B. All equipment shall be securely and rigidly mounted. Equipment shall be mounted in locations approved by the Engineer and out of the way of potential damage. Items shall be installed so as to provide ease of maintenance and operation. Equipment shall not be installed where it impedes access or egress within an area. In addition, the installation shall not block or impede maintenance or operational access to other equipment.

C. Instruments and indicators shall be installed to allow the operator or service personnel to read the device while at the local control location of the associated equipment. When no local control location is provided, a central location at the equipment shall be chosen by the Engineer. All indicators and readouts shall be located so as to be readable from that area and the process floor.

3.03 FIELD TESTING / QUALITY CONTROL

A. All equipment shall be tested in accordance with Section 23 09 15 - Instrumentation and Controls Systems Testing, Installation and Start-up for HVAC.

3.04 STARTUP / DEMONSTRATION

A. General:

1. To familiarize the City's personnel with the HCS, field instrumentation and the HVAC process control system, training shall be provided on all

equipment and services provided under this Contract, as indicated in the Specifications, and as specified herein. All costs of providing the training courses shall be borne by the Contractor. All training courses shall be conducted under the direction of a training director who shall design a detailed training plan that complements the experience and skill levels of the City's personnel. All training shall be completed prior to or immediately after system startup. All training activities conducted shall meet the requirements of Specification 01 79 05 – Equipment Start-up and Training . As a minimum, training shall be provided for the following:

a. PLCs including basic ladder programing, documentation, etc.

b. Project specific PLC application programs.

c. Control panels and their operation.

d. All instruments, controllers, elements, controls, etc.

e. Control Strategies.

f. HVAC equipment and system operation from control system

2. Training Aids:

a. The manufacturer’s instructors shall incorporate training aids as appropriate to assist in the instruction. At a minimum, the training aids shall include text and figure handouts. The manufacturer shall turn over all the training aids to the City. Other appropriate training aids are:

1) Audio-Visual aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets).

2) Equipment cutaways and samples (e.g., spare parts, damaged equipment).

3) Tools (e.g., repair tools, customized tools, measuring and calibrating instruments).

b. The manufacturer’s instructors shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts shall accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer's proposed Lesson Plans.

3. "Hands-On" Demonstrations:

a. The manufacturer’s instructors shall present "hands-on" demonstrations of common corrective maintenance repairs and

troubleshooting of common problems associated with all installed equipment. Two presentations for mechanical repairs and two involving electrical repairs will be made for each. The manufacturer shall provide the tools and equipment to conduct the demonstrations and calibration units as needed. Requests for supplemental assistance and facilities should be submitted with the manufacturer's proposed Lesson Plans. The proposed "hands-on" demonstrations shall be described in the manufacturer's proposed Lesson Plans and shall be specific for equipment installed.

b. In any "hands-on" training situation where City's operations or maintenance personnel participate in disassembly or assembly equipment components, the manufacturer shall be responsible for such disassembly or assembly and shall provide written certification of proper equipment operation to the City.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall, through the services of the Heating and Ventilating Control Systems Supplier (HCS Supplier), furnish, install, test and place in operation, HVAC process instrumentation and control devices, as detailed herein and as shown on the Contract Drawings. The instruments and controls shall be top quality, standard offerings of a nationally recognized manufacturer. When available, instruments and/or control devices shall be procured from a single manufacturer. The equipment shall be installed in accordance with the Specifications, manufacturer's recommendations and best industry practice. Instruments and controls shall be installed complete with all process connections, supports, mounting brackets and hardware, conduit and wiring, terminations, etc. to provide a complete and properly functioning installation.

B. The following index of this Section is presented for convenience:

C.

D. The Contractor shall provide all necessary process taps, isolation valves, nipples, penetrations, instrumentation supports, etc. required to provide a complete and operational installation. Conduits, raceways, wiring, junctions for control and signal wiring shown on the Contract Drawings and as required for a complete installation shall be provided under this Contract.

E. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the sizing, location, orientation and dimensions of instruments and the connections and taps for instrumentation furnished under this Division are such as to provide the required accuracy of measurement, the proper bracing, and protection of the sensor from accidental damage and accessibility for maintenance.

F. It shall be the responsibility of the HCS Supplier to provide instruments that have been properly sized and applied to the process in which they are to be used. The HCS Supplier shall calculate the proper size, range, material, location, orientation and set point for all instruments provided under his Contract to give the most accurate readings in the appropriate ranges. Calculations shall be submitted with the instrument for approval. Unless otherwise noted, instruments shall be selected so that the expected nominal operating range is within the middle 1/3 of the instrument’s scale.

G. All instrument taps shall be provided with isolation valves or thermo-wells to permit testing, calibration and replacement without shutdown of process or system. A test port and block valve for in-place calibration shall be installed for each instrument.

H. As part of his testing, the Contractor shall assume the responsibility of testing of all electrical work associated with this system.

I. The Contractor shall furnish and install supply and return pressure gauges and thermometers as specified herein at all points indicated on Contract Drawings, where piping enters or leaves all buildings (or areas of buildings, elevations) and where piping attaches to equipment. In addition, pressure gauges shall be provided on both sides of all pumps, pressure control valves, regulators, strainers, filters and points of attachment to other and existing plant services as well as

J. Instruments and controls shall be correctly interfaced to the system and equipment to which they are associated and connected. Mounting brackets and/or stands, hardware, anchors and appurtenances shall be furnished and installed as required.

K. Instruments shall be installed in logical groups associated with a specific piece of equipment or system and shall be readable from a central location near the associated equipment. Instruments shall be oriented so as to be easily readable from the floor.

L. In addition to those shown on the Contract drawings, the Contractor shall furnish and install thermometers and pressure gauges as described herein at the following locations.

1. Inlet and outlet of all heating and cooling coils, AHUs, ACs, HVs, etc.
2. Inlet and outlet of all heat exchangers
3. All common supply and return headers
4. Supply and return branch connections to heating zones
5. Supply and return branches in each area
6. Supply and return piping when penetrating floors and between areas and buildings

M. In addition to those shown on the Contract drawings, the Contractor shall furnish and install pressure gauges as described herein at the following locations.

1. All water headers
2. Before and after all pressure regulators and reducing stations
3. On both sides of strainers and filters
4. At all feed points and connections between disciplines and systems

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC

B. Section 23 09 15 – Instrumentation and Controls system Testing, Installation and Startup for HVAC

C. 23 09 14 – Control panels Enclosures and Devices for HVAC

D. 22 05 23.12 – Ball Valves for Plumbing Piping

E. 22 05 23.14 – Check Valves for Plumbing Piping

1.04 REFERENCES

A. All equipment and services provided herein shall be in accordance with the references stated in Section 23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC.

B. Reference Standards:

1. ASTM American Society for Testing and Materials Standard A774 As-Welded Wrought Austenitic Stainless-Steel Fittings for General Corrosive Service at Low and Moderate Temperature, Standard A269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service
2. SAMA Scientific Apparatus Makers Association, Standard RC17-10-1963 - Bushings and Wells for Temperature Sensing Elements

1.05 DESCRIPTION

A. Instrumentation/controls specifically identified in the Contract Drawings as being furnished with mechanical equipment shall be furnished and installed by the vendor or as specified elsewhere in the Contract Documents but will be calibrated and tested under this Section for proper operation and interface with the HCS.

B. Electrical conduit and wire specifically shown on the electrical Contract Drawings.

C. Signals:

1. All electronic instruments (transmitters) shall provide a linear 4 to 20 milliamp signal at a nominal 24VDC. The signal shall be proportional to the process variable indicated. Signal conditioning (such as square root extraction or frequency conversion), if needed, shall be done by the transmitter electronics.
2. All electronic devices (when available) shall be the microprocessor based "smart" type. Milliamp signals (4 - 20mAdc) shall have a superimposed Hart digital signal which will allow for remote communication with these devices. Handheld programmers shall be provided.
3. Discrete switch closure contacts shall use nominal 120 VAC control voltage. 24 Vdc discrete contact closures shall be used where indicated. All devices shall be rated for 120 Vac as a minimum. Contact rating shall be 2 amp minimum unless otherwise noted.

D. Units:

1. Units shall be as follows:

2.	VARIABLE	UNITS
3.	Temperature	Degree F
4.	Pressure	
5.	- Below atmospheric	Inches of Hg Absolute
6.	- Near but below Atmospheric	Inches of Water
7.	- Above Atmospheric	PSIG
8.	- Absolute	PSIA or Inches of Hg Absolute

9.	Level	0 to linear feet or quantity
10.	Flow	
11.	- Liquids	GPM. @ 60 degrees F
12.	- Gas or Vapor	SCFM @ 60 degrees F and 14.7 PSIA
13.	Relative Humidity	0-100%
14.	Capacity	0-100%
15.	Heating Load	BTUs
16.		

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for all equipment and work provided, for the approval of the Engineer.

B. Submittals shall include, but not be limited to:

1. Completed ISA S20 data sheets, installation and instruction manuals, operation and maintenance manuals, for each and all items provided under this Section, for review and approval. Each item's data sheet shall have a complete listing of tag numbers to which that data pertains.
2. Manufacturer's installation, operation and maintenance manuals.
3. Software, manuals and configuration data for all units requiring programming and/or configuration.
4. Shop Drawings and descriptions of supports, mounting details and process connections and taps for all instruments.
5. Calculations, assumptions and manufacturers recommended installation requirements indicating the methods used in proper sizing, location and orientation of all instruments.
6. Instrument installation layout drawings showing proposed locations of all instruments and equipment. The drawings shall be done to scale and dimensioned on a background of equipment and piping.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Deliver all spare parts, tools and supplies with the equipment, neatly wrapped and boxed, indexed and tagged with complete information on their use and reordering.

B. Provide all of the individual manufacturers recommended spare parts and tools for all equipment specified herein. In addition to the recommended spares, furnish all of the following minimum spare parts, tools and devices:

1. General

   a. 10% (minimum of 10) spare fuses, indicating lights, etc., for each size and type provided.

2. Electronic Field Instruments

   a. One complete spare instrument of each type for every 10, or part thereof furnished (minimum of 2). Included shall be any integral indicators, adapters, converters and modules needed to provide a complete functional replacement. Where similar units have been provided having different characteristics or ranges, the aforementioned quantities shall pertain to each type. Where instruments of the same type having different ranges are provided and the unit can be rescaled by field adjustment, the quantities listed shall apply to the total number provided.

3. Primary Sensing Elements

   a. One spare of each size and type, complete with housing and appurtenances for each 10 or part thereof installed (Minimum of 1).

4. Pressure and Temperature Switches

   a. One spare of each size, type and range, complete with housing and appurtenances for each 5 or part thereof installed (Minimum of 2).

5. Panel Mounted Instruments

   a. (Includes Loop Controllers, Digital Indicators, Run Time Meters, Isolators, converters, etc.)

   b. One spare of each size, type and range, complete with housing and appurtenances for each 10 or part thereof installed (Minimum of 2).

   c. In addition to the spares required above, the Contractor shall provide:

      1) One spare power supply for every 5 or part thereof installed (Minimum of 2).

      2) One spare electronic module, indicator and/or circuit board for every 5 or part thereof installed (Minimum of 1).

      3) One complete set of memory modules for each controller installed with the current program preloaded.

6. Non-Electronic Gauges, Indicators, Thermometers, etc.

a. One spare gauge or indicator of each size, type and range, complete with appurtenances (diaphragms, snubbers, thermo-wells, capillaries, etc.) for each 10 or part thereof installed. All units shall be tested, certified and ready for use. Units with diaphragm seals, remote capillaries, etc., shall be filled, tested as a unit and ready for use.

b. One spare isolation/calibration valve of each size and type for each 20 installed. (Minimum of 1).

c. One spare appurtenant device (snubbers, manifolds, diaphragms, etc.) of each size and type for each 10 installed. (Minimum of 1).

7. Valves

a. Provide 1 valve body packing and rebuild kit of the correct type with each 10 valves provided or part thereof.

b. Provide 1 spare valve of each size and type for each 5 or part thereof installed.

8. Actuators

a. Provide 1 spare actuator of each size, type and rating (valve and damper, two position and modulating) for each 5 or part thereof installed.

9. Fuses

a. Provide 10% spare fuses (minimum of 10) for each type and rating used in field and panel instrumentation. (Including test equipment).

C. Tools:

1. Special tools required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance shall be provided (i.e., connector pin insertion and removal tools, wire crimping tool, special wrenches, special instrument calibrators/configurators, indicator lamp insertion and removal tools, etc.).

2. The Contractor shall furnish all tools and test equipment, complete with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for field testing or maintaining equipment supplied under this Contract.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Refer to section 2.02

2.02 MATERIALS / EQUIPMENT

A. Pressure Indicators

1. Pressure Gauges

a. The Contractor shall furnish and install pressure gauges as stated herein.

1) When gauges are to be mounted with a centerline height between 10 feet to 12 feet above finished floor, the gauge dial diameter shall be 8 inches. As an alternative, 4½ inch gauges may be wall or stand mounted at eye level and tubing run to the process connection.

2) Isolation valves shall be provided both at the process connection and at the instrument.

3) Pressure connections shall be 1/2 inch NPT with isolation and test valves provided.

2. Differential Pressure Indicators

a. The Contractor shall furnish and install differential pressure indicators (gauges) as indicated for pressure gauges above, and as specified herein.

1) Element type: Bourdon tube gauge assembly encapsulated in a pressure chamber shall be used for differential pressure measurement above 10 psig. For measurement of differential pressure below 10 psig multiple diaphragm assembly supported on bulkhead plate housed in pressure chamber shall generally be used.

2) Element material: Material for measuring element shall generally be stainless steel as a minimum. Gauges used for air service may be Berillium or Phosphor Bronze, or approved equal.

3) Operation: Piston operated differential gauges shall be considered as an alternate to measure pressure drop across filters, valves and equipment.

4) Manufacturers: Indicators shall be as manufactured by Weiss, Ashcroft, Dwyer, or approved equal.

5) Indicators used to indicate flow shall have their dial calibrated in flow units. Flow measurement gauges shall be installed with air venting valves, blow down valves, and a balancing valve for zeroing.

B. Pressure and Differential Pressure Instruments

1. Pressure and Differential Pressure Switches

a. The Contractor shall furnish and install pressure and differential pressure switches and as specified herein.

1) Element: Low pressure draft and water column range units shall use slack diaphragm elements.

2) Adjusting Mechanism: Pressure setting values for the range specified shall be indicated on a pressure setting scale. The normal operating range shall be within the middle one-third of the total scale.

3) Dead band: Pressure adjustments shall include an adjustable dead band.

4) Accuracy: +/- 1% of scale.

5) Electrical connections: Electrical connections to the switch unit shall be by terminal lugs. In lieu of terminal lugs, a minimum of 19 inch free leads are acceptable for explosion-proof model only. In this case, the leads shall be hermetically sealed, where leaving the switch housing and the seal must be listed by FM and/or UL. When lead type connections are furnished, a separate junction box shall be provided, connected to the switch with flexible conduit and installed. The unit and included box shall comply with all requirements of Division 16 and all area classifications.

6) Pulsation Dampeners: Pulsation dampeners shall be provided for all pressures instruments subject to sudden pressure surges and/or pressure fluctuations, e.g., pump discharge. Pulsation Dampeners shall have 1/2 inch NPTM switch connection and 1/2 inch NPTF process connection. Pulsation dampener material shall generally be 316 SS as a minimum. Pulsation dampeners shall be selected from, multiple hole, piston and filter type, etc., depending upon process fluid, pressure and temperature requirements.

7) Over range protection: Pressure switches shall be designed to withstand inadvertent application of pressure equal to 1.5 times full scale pressure as a minimum.

8) Manufacturer: SOR, Ashcroft or approved equal for high and medium pressure service and Dwyer, Preferred, or approved equal for low pressure service.

2. Pressure and Differential Pressure Transmitters

a. The Contractor shall furnish and install pressure and differential pressure transmitters as specified herein.

1) Process connection: Process connections shall be 1/2 inch NPTF. Transmitter body shall be provided with drain plug and vent valves. Valve and plug material shall be type 316 stainless steel as a minimum. All differential pressure transmitters shall be provided with a 3-valve calibration manifold.

2) Adjustments: All zero and span adjustments shall be non-interacting. Transmitter output shall be 4 to 20 maDC proportional to measured variable i.e. differential pressure transmitters used for flow measurement shall have their indicators and outputs linearized to flow.

3) Zero adjustment: Zero elevation and suppression shall be built in to the standard transmitter and be adjustable over a range equivalent to a minimum of 50% of calibrated span.

4) Transmitters used for flow measurement (with annubar, venturi, etc.) shall be temperature compensated multivariable type. Units shall be Rosemount 3059 MV or approved equal. Furnish and install temperature element as specified herein. Conduit and wire between element and transmitter shall be provided under this Contract.

5) Remarks: Transmitters used for gas service shall be approved for the application. Installation of such units shall comply with all codes and regulations.

C. Flow Instruments

1. Positive displacement water flow meters/totalizers

a. The Contractor shall furnish and install water flow meters as stated herein. Provide positive displacement flow elements and transmitters where required by the Contract Documents.

1) Function: Indicate and transmit flow rate and totalization data of system makeup water.

2) Type: Compound flow meter utilizing disk type element for low flow conditions and turbine type element for high flow conditions.

3) Material: Case & cover, water works bronze 75% copper; case bolts, type 316 stainless steel; turbine spindles, Tungsten carbide or stainless steel.

4) Elements: AWWA class II dual suspension turbine and nutating disk.

5) Size: 2 inch.

6) Operating Pressure: 175 psi.

7) Operating Temperature: 250 degrees F.

8) Flow rate: nominal: 1/2 to 160 gpm

9) Max: 200 gpm

10) Max head loss @ full flow: 7 psi.

11) Display: Direct reading magnetic drive registers with low flow indicator. Units shall be US gpm.

12) Transmitter: Pulsed output proportional to flow rate. A signal conditioner shall be provided to convert to 4 - 20ma flow signal. Integration (totalization) shall be performed in the main PLC for display and reporting by HCS.

13) Calibration: Cover mounted stainless steel calibration vane.

14) Accessories: Provide full size manufacturers recommended plate type upstream strainer.

15) Manufacturer: AMCO, Dwyer or approved equal.

16) Model: C3000 Compound Meter.

17) Meter shall be installed horizontally at a maximum height of 4 feet above finished floor and shall be easily accessible and readable.

D. Temperature Indicators

1. Temperature Gauges (Thermometers)

a. The Contractor shall furnish and install temperature indicators as stated herein.

1) Function: Indication of temperature.

2) Type: Industrial mounted bimetallic or gas filled (when required) type dial thermometer.

3) Case: hermetically sealed stainless steel case and bezel. The unit with glass shall be moisture proof.

4) Glass: Heavy duty polycarbonate or shatterproof glass, gasketed to bezel and case.

5) Dial: Heavy gauge aluminum, 5 inch, white matt finish with black graduations and numerals, 270 degree readable dial scale.

6) Accuracy: +/- 1% of scale range.

7) Mounting: Minimum of 1/2 inch stainless steel NPT male thread and 1/4 inch diameter stem, 180 degree variable angle dial head and 360 degree dial face rotation. Stem length ("U" dimension) shall be sized to place the stem tip in the center of the vessel or pipeline. Stainless steel 3/4 inch (minimum) NPT male thermo-wells of the proper length shall be provided for all units.

8) Vibration: Where subject to vibration units shall be furnished with silicone liquid filling. Where subject to severe vibration or where mounting height would be above 12 feet, remote mount, gas actuated units with capillary tubing as required shall be provided.

9) Capillary: Where required by height or vibration restrictions (as above), shall be stainless steel tubing with interlocking stainless steel armor over the entire length.

10) Adjustments: Units shall have external recalibration means.

11) Manufacturers: Thermometers shall be as manufactured by Weiss Instruments Inc., Ashcroft, or Trerice, or approved equal.

E. Temperature Instruments:

1. Temperature Indicating Transmitters

a. The Contractor shall furnish and install temperature elements and transmitters as specified herein.

b. The transmitter shall be separate from the element and shall be stand or wall mounted at 5 feet above finished floor. Elements shall be spring loaded, three wire, 0.385 alpha, 100 ohm platinum RTDs with dual elements (one spare). Conduit and cable shall be provided between the units under this Contract as required.

c. 3/4-inch 316 stainless steel thermo wells shall be provided for all elements

2. Temperature Switches:

a. The Contractor shall furnish and install temperature switches as specified herein.

1) Type: Close coupled direct mount or remote mount where required of ectromechanical type.

2) Contacts: Hermetically sealed SPDT snap action type UL listed 250 VAC, 5A.

3) Housing: NEMA 4X copper free aluminum.

4) Mounting: Minimum of 1/2 inch Stainless steel NPT male thread and 1/4 inch diameter stem. Stem length ("U" dimension) shall be sized to place the stem tip in the center of the vessel or pipeline. Stainless steel 3/4 inch (minimum) NPT male thermo-wells of the proper length shall be provided for all units.

5) Range: Refer to Instrument Range Data.

6) Adjusting Mechanism: Temperature setting values for the range specified shall be indicated on a temperature setting scale. The normal operating range shall be within the middle one-third of the total scale.

7) Dead band: Where possible, temperature adjustments shall include an adjustable dead band.

8) Accuracy: +/- 1% of full scale.

9) Electrical connections: Electrical connections to the switch unit shall be by terminal lugs. In lieu of terminal lugs, a minimum of 19 inch free leads are acceptable for explosion-proof model only. In this case, the leads shall be hermetically sealed, where leaving the switch housing and the seal must be listed by FM and/or UL. When lead type connections are furnished, a separate junction box shall be provided, connected to the switch with flexible conduit and installed. The unit and included box shall comply with all requirements of Division 16 and all area classifications.

10) Over range protection: Temperature switches shall be designed to withstand inadvertent application of temperature equal to 1.5 times full scale rating as a minimum.

11) Manufacturer: SOR, Ashcroft or approved equal.

F. Panel Mounted Instruments

1. Digital Indicators

   a. The Contractor shall furnish and install digital indicators as specified herein.

      1) Function: Display of calculated or real world process variables. Various signals are called out for digital display in the Contract Drawings. Any signals that cannot be displayed on the face of the appropriate SLC (the signal to be displayed must be related to the major function of the SLC), shall be displayed on combination bar graph-numeric readout display units.

      2) Field and Panel Indicators: Unless otherwise noted, alpha-numeric display of indicators mounted in the field shall be LCD type panel mount shall be LED type. The height of alpha-numeric display shall be 1/2-inch minimum. External power supplies shall be provided as needed. Indication shall be in engineering units with a minimum of 1 decimal place display resolution (i.e. XXX.X degree F).

2. Run Time Hour Meters

   a. Type: Provide a synchronous motor driven run-time hour meter with 0.1 hour resolution.

   b. Manufacturer: Cramer, or approved equal.

3. Signal Conditioners

   a. The Contractor shall furnish and install signal converters as specified herein.

      1) Function: Translation of incompatible signal types, ranges, voltages etc. for use by process control equipment.

      2) Type: Converters shall be of the plug in type, utilizing all solid state circuitry suitable for rack mounting within panels.

      3) Power supply: 120VAC, 60 Hz where required by the converter.

      4) Accuracy: 0.1% of span, dead band shall be 0.1% span, maximum.

      5) Where specific converters are not listed, but are required to interface with the current or future process control system, they shall comply with the requirements stated herein.

4. Current Isolators

a. The Contractor shall furnish and install current isolators as specified herein.

1) Function: To provide an isolated current loop, calculations or signal amplification between the plant's new, future and existing process control systems and existing analog instrumentation and control loops.

2) Type: Converters shall be of the plug-in type, utilizing all solid state circuitry suitable for rack mounting within panels.

3) Power supply: 120VAC, 60 Hz where required by the converter.

4) Accuracy: 0.1% of span, dead band shall be 0.1% span, maximum.

5) Circuit loading: Isolators shall be sized such that resistance of new or existing loops shall not exceed maximum rated resistance.

6) Manufacturer: Moore Industries, or approved equal.

5. Current Switch Alarms (alarm trips)

a. The Contractor shall furnish and install current switch alarms as specified herein.

1) Function: To determine fan motor status point in remote starter enclosures.

2) Type: Digital output, solid-core, SPDT relay current sensing switch calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3) Power supply: Self powered induced from line.

4) Alarm Trips: Adjustable setpoint 0.5-200amps

5) Output: SPDT; 1amp rating at 30 VAC/VDC.

6) Manufacturer: Veris-Hawkeye, or approved equal.

G. Piping and Fittings

1. Piping and fittings for connection of instrumentation shall be stainless steel pipe in accordance with the following:

a. General:

1) Piping shall be fabricated in accordance with ASTM A312 from type 316L stainless steel.

2) The pipe shall be subjected to hydrostatic and flattening tests as specified in ASTM A530.

3) All welds shall be free from burrs, snags or rough projections.

4) Where instrument piping is run a distance greater than 24 inches and where directed by the Engineer, 1/2 inch OD, 316 stainless steel tubing shall be used. Fittings shall be 316 stainless steel flareless "Swagelok" or approved equal.

b. Wall Thickness:

1) Shall be schedule 40S for 1/2 inch pipe sizes. The wall thicknesses for the above schedules shall conform to ANSI B36.19.

c. Fittings:

1) Shall be fabricated from type 316L stainless steel in conformance with ASTM A774 of the same wall thickness as specified for the pipe.

2) Shall conform to the requirements of ANSI B16.9 Standard for Factory Made Wrought Steel Butt Welding Fittings. Elbows shall be long radius.

3) Fittings shall be subject to the same hydrostatic test as the pipe.

H. Automatic Temperature Control Devices

1. Thermostats

a. The Contractor shall furnish and install room thermostats in all areas unless otherwise noted, in accordance with the following.

1) Function: Temperature based on / off control of heating and cooling equipment.

2) Type: Industrial, single or two stage, line voltage on / off control.

3) Switch Type: Single or dual, sealed, snap action contacts.

4) Contact Rating: 120Vac, 7.4A.

5) Operating Range: 35 - 100 degrees F.

6) Maximum Ambient: 145 degrees F.

7) Enclosure: NEMA 4X; clear plastic cover; tamper proof setting dial, visible through cover; external mounting tabs.

8) Sensor: external coiled capillary, tinned copper/ corrosion resistant.

9) Adjustments: Internal set point, adjustable interstage differential.

10) Provide separate HAND-OFF-AUTO switch in NEMA 4X enclosure as required.

11) Manufacturer / Model: Honeywell T631F, G, or approved equal.

2. Temperature Elements/Transmitters

a. The Contractor shall furnish and install temperature elements and transmitters as specified herein.

b. Function: Measurement of air and water temperatures of environmental air systems for transmission to HCS/PLC control system.

c. Transmitter: Loop powered, 3-wire RTD to 4-20 mAdc mounted in cast iron probe head. The unit shall have 0.1% full scale accuracy with integral zero and span adjustments. Hart protocol shall not be required.

d. Indicator: Loop powered local LCD indicators shall be furnished and installed when indicated. As a minimum, all room sensors shall have local indicators. Indicators shall be mounted in an easily visible location with the centerline at 5 feet 0-inch above finished floor. The unit shall comply with requirements specified under the section on Digital Indicators above. The enclosure shall be in accordance with Specification 23 09 14.

e. Manufacturer:

1) Omega Engineering Inc. Model: (Probe) type PR-12, (transmitter) TX-92,

2) Or approved equal.

3. Valve Actuators (Two Position and Modulating)

a. The Contractor shall furnish and install valve actuators in accordance with the following.

1) Function: Electrically controlled operation of small valves .

2) Type: Commercial, 120 Vac, 2 position, high torque, spring return to closed position and modulating actuators.

3) Aux Switch Type: 2 sets, adjustable snap action contacts, 120Vac 7.2A.

4) Rating: 120Vac, w/screw terminal adapter.

5) Modulating signal: 4 to 20 mAdc.

6) Operating Range: -40 - +150 degrees F.

7) Mounting: External mounting foot.

8) Enclosure: Cast aluminum, NEMA 4X.

9) Motor/Gear Train: Oil immersed.

10) Mechanical ratings: 160 degree stroke, 60 seconds, 60 lb-in. Torque (min).

11) Accessories: Furnish and install NEMA 4 power disconnect switch for each operator.

12) Manufacturer / Model: Honeywell M4185, 86 or approved equal (2 position) and Honeywell M7284 (modulating) or approved equal.

4. Freeze-stats

a. The Contractor shall furnish and install freeze-stats (low temperature switches) in accordance with the following.

1) Function: To provide a switch contact change of state in response to a low temperature (near freezing) condition at the outlet side of an air handling unit's heating coil.

2) Type: Coil face mounted, extended capillary sensor with manual reset snap action switch.

3) Range: 30 to 60 degrees F.

4) Switch Rating: SPDT 5A, 120Vac.

5) Housing: NEMA 4X, gasketed.

6) Capillary: 1/8 inch x 20 feet (minimum) copper with mounting clips (additional units shall be provided for larger coils or multiple coils as required).

7) Manufacturer: Honeywell, Barber-Coleman or approved equal.

8) The capillary shall be mounted on the downstream side of the heating coil and shall be extended in a zig-zag pattern to cover the entire coil face or in accordance with the manufacturer's written recommendations. The unit shall

respond to the lowest temperature over any one-foot section of the capillary. Multiple units shall be provided for HVAC units having large coils and / or multiple coils to obtain proper coverage and protection. In addition to indicating a freeze condition to the HCS, the units shall be hardwired into the unit control panel and fan control circuit to provide shutdown of the unit. Upon activation, any circulating pumps shall remain operating or shall be started to prevent freezing of the coils. Units shall require manual reset.

5. Differential Pressure Switches

   a. The Contractor shall furnish and install filter differential pressure switches in accordance with the following.

      1) Function: To provide a switch contact change of state in response to increased differential pressure.

      2) Type: Low pressure (<1 inch w.c.) two port differential pressure switch.

      3) Range: 0.2 to 1.0 inch of water column.

      4) Switch Rating: SPDT 15A, 120Vac, form “C” contact.

      5) Housing: NEMA 4X.

      6) Tubing: 1/4 inch ID stainless steel (tubing shall be straight with machine bent corners and securely fastened, provide connection fittings as required).

      7) Manufacturer: Dwyer, or approved equal.

      8) Model: 1638.

6. Filter Differential Pressure Switch/Indicators

   a. The Contractor shall furnish and install filter differential pressure indicators in accordance with the following.

      1) Function: To provide indication and alarm of differential pressure across a filter bank and provide alarm functions on increased differential pressure due to dirt accumulations on filter media.

      2) Type: Low pressure (<1-inch w.c.) two port differential pressure indicator and switch with dual setpoint indicator/adjustment pointers.

      3) Range: 0 to 1.0 inch of water column.

4) Switches: One form "C" contact for each setpoint rated 1A at20 to 280 Vac. Adjustable high and low setpoint indicators.

5) Housing: die cast aluminum, Iridite dipped. Unit shall be semi flush mounted in a NEMA 4X stainless steel enclosure with power supply, tubing and electrical connections and wiring terminals.

6) Connections: 1/8 inch NPTF connection tubing shall be stainless steel (tubing shall be straight with machine bent corners and securely fastened, provide connection fittings as required).

7) Manufacturer: Dwyer, Photohelic, or approved equal.

8) Model: Series A3000MR.

9) Switch/indicators shall be provided for all HVAC units having filters. Where multiple filter types are employed, (paper, carbon, metal, etc.), each filter type shall have an individual indicator. Units shall be panel mounted or mounted in a separate NEMA rated box. Units shall be piped to the filter location and alarm switch.

7. Control Valves (2 inch and smaller)

a. The Contractor shall furnish and install 2-inch and smaller control valves in accordance with Section 40 05 56 – Valves Smaller than 4 Inches and the following:

1) Function: To provide on/off or modulating flow control of hot or cold water in heating / cooling hydronic systems.

2) Type: Linear control and constant total flow globe valves.

3) Material: Body-Cast Bronze, Disk and Seat-brass, Stem-Stainless steel.

4) Temperature range: 40 degrees F to 250 degrees F.

5) Flow Characteristics: Two way or three way (as required), linear, constant total flow through full plug travel.

6) Leakage: Class IV (0.05% of Cv).

7) Manufacturer: Honeywell V5013N, or approved equal.

8) Actuator: See above.

9) Remarks: The valve shall be supplied from the factory with the manufacturer's properly sized electric motor driven actuator. The valve shall be properly sized by the Contractor

for optimum control based on the manufacturer's published data, control system and hydraulic requirements. Isolation and bypass valves and threaded unions shall be installed at all connections to allow easy removal of the valve for servicing while maintaining water supply to the unit.

8. Control Valves (2 1/2 inch to 6 inch)

   a. The Contractor shall furnish and install 2 1/2 through 6 inch control valves in accordance with the Specification 22 05 23.12 – Ball Valves for Plumbing Piping, 22 05 23.14 – Check Valves for Plumbing Piping and the following:

      1) Function: To provide on/off or modulating flow control of hot or cold water in heating / cooling hydronic systems.

      2) Type: Two way or three way (as required), linear control and constant total flow globe valves.

      3) Material: Body-Cast Iron ANSI CLASS 125 flanges, Trim-Bronze, Stem- Stainless steel.

      4) Temperature range: 40 degrees F to 250 degrees F.

      5) Dimensions: Per ISA 75.03 Face to face.

      6) Packing: Teflon cone.

      7) Flow Characteristics: Three way, equal percentage.

      8) Leakage: Class IV (0.01% of Cv).

      9) Manufacturer: Honeywell V5011, V5013B (mixing) and V5013C (diverting) or approved equal.

      10) Actuator: See above.

      11) Remarks: The valve shall be supplied from the factory with the manufacturer's properly sized electric motor driven actuator. The valve shall be properly sized by the Contractor for optimum control based on the manufacturer's published data, control system and hydraulic requirements. Isolation and bypass valves and threaded unions shall be installed at all connections to allow easy removal of the valve for servicing while maintaining water supply to the unit.

9. Control Valves (Larger Than 6 inch)

   a. The Contractor shall furnish and install control valves larger than 6 inch in accordance with the Specification 22 05 23.12 – Ball Valves for Plumbing Piping, 22 05 23.14 – Check Valves for Plumbing Piping and as indicated herein.

1) Function: To provide on/off or modulating flow control of hot or cold water in heating/cooling hydronic systems.

2) Type: Linear control and constant total flow globe type valves with skirt guided V port plug.

3) Material: Body-Cast Iron ANSI CLASS 125 flanges, Trim - 316 Stainless Steel, Stem- Stainless steel.

4) Temperature range: 0 degrees F to 450 degrees F.

5) Dimensions: Per ISA 75.03 Face to face.

6) Packing: Teflon V Ring.

7) Flow Characteristics: Two way or three way, equal percentage, mixing.

8) Leakage: Class IV.

9) Manufacturer: Dezurik Series 1600 model 1601 or approved equal.

10) Actuator: Pneumatic diaphragm direct or reverse acting as required. Failure mode (either air or signal) spring to bypass position, 3-15 psi with 4-20mAdc positioner and 4-20mAdc position feedback, Diaphragm - Buna N with nylon insert.

11) Remarks: The valve shall be supplied from the factory with the manufacturer's properly sized diaphragm driven actuator and positioner. The positioner shall have indicator gauges for supply, input and output air pressure. The valve shall be properly sized by the Contractor for optimum control and minimum head loss based on the manufacturer's published data, control system and hydraulic requirements. Head loss and control characteristics shall be coordinated with the system requirements. Provide gauges and valves on all air lines. Instrument air piping and conditioning equipment shall be provided under this Contract.

I. Ionization Type Smoke Detectors (4 Wire Type for Non-Classified Areas)

1. Furnish and install ionization type duct smoke detectors in the supply and return air ducts or plenum of each H&V unit and in the exhaust air duct of systems where shown on the Drawings.

2. The detector housing shall be listed per UL 268A specifically for use in air handling systems. The detector shall operate at air velocities of 500 to 4000 feet per minute. The detector housing shall be equipped with an integral mounting base capable of accommodating either photo electronic or ionization detector heads. It shall be capable of local testing via remote

testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL 268A, Standard for Smoke Detectors for Duct Applications. The housing shall be capable of mounting to either rectangular or round ducts without brackets. An integral filter system shall be included to reduce dust and residue effects on detector and housing, thereby reducing maintenance and service.

3. Detectors shall be provided with two sets of contacts to provide smoke alarm signals. One is to be used by the HVAC ATC systems, and the second to be used for interface to a central fire alarm system.

4. Remote test station and alarm indicator stations shall be furnished for all duct smoke detectors as specified above. The detector shall be reset by the remote test station. The installation and wiring of the remote stations will be provided under this Section. The remote test stations shall be wall or column-mounted within the visible location of the smoke detector and easily accessible from the floor. The test station shall be key-operated, with "Test', "On", and "Reset", positions.

J. Electric and Electronic Actuators

1. Damper Actuators (Two Position and Modulating)

a. Type: Motor operated, with or without gears, electric and electronic.

b. Manufacturers:

1) Ruskin

2) Johnson Controls

3) Belimo

4) Or approved equal.

c. Voltage:

1) 24 V.

2) Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

3) Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

d. Construction:

1) Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

2) 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

3) Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

e. Field Adjustment:

1) Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.

2) Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

f. Two-Position Actuators: Single direction, spring return or reversing type.

g. Modulating Actuators:

1) Capable of stopping at all points across full range, and starting in either direction from any point in range.

2) Control Input Signal:

a) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 4 to 20 mA signals.

h. Position Feedback:

1) Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

2) Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

3) Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

i. Fail-Safe:

1) Where indicated, provide actuator to fail to an end position.

2) Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.

3) Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

j. Integral Overload Protection:

1) Provide against overload throughout the entire operating range in both directions.

2) Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

k. Damper Attachment:

1) Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.

2) Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

4) Contract drawings are diagrammatic. The actual quantity and location of damper/louver actuators required is to be determined by the Contractor and manufacturer. The actual load on any one actuator shall not exceed 80% of continuous rating. Additional actuators shall be furnished and installed to achieve the needed torque at no additional cost to the City. When additional actuators are provided, the limit switches shall be series connected. The Contractor shall provide the proper mounting hardware, linkages and adapters required for all units. Linkages shall be furnished and installed as recommended by the valve, damper and actuator manufacturer. End limit switches are required and shall be provided on all two position units. The switches shall be connected so that all units must complete full travel (minimum of 85%) before activation of the circuit (contacts close). Switches shall be adjustable over the entire range. All actuators shall be housed in separate NEMA 4X enclosures.

l. Temperature and Humidity:

1) Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of -40 to +150 degrees F.

2) Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

m. Enclosure:

1) Suitable for ambient conditions encountered by application.

2) NEMA 250, Type 2 for indoor and protected applications.

3) NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.

4) Provide actuator enclosure with a heater and controller where required by application.

n. Stroke Time:

1) Select operating speed to be compatible with equipment and system operation.

o. Sound:

1) Spring Return: 62 dBA.

2) Non-Spring Return: 45 dBA.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. All instruments shall have an engraved stainless steel information tag. As a minimum the tag shall indicate the full instrument tag number, manufacturer, model, range and serial number. The tags shall be affixed with stainless steel screws. When screw mounting is not possible, a braided stainless steel lanyard shall be used. Characters shall be 1/8 inch minimum.

B. Each wall or stand mounted electronic instrument shall have mounted adjacent to it an engraved laminated tag, (white with 1/4 inch black letters), indicating tag number, system, subsystem and measured variable. Engravings shall be approved by the Engineer.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. General

1. Instruments shall be installed and oriented so as to be easily accessible and readable from the process floor.
2. Pressure gauges, thermometers, flow indicators, etc. when possible, shall be grouped and oriented so that all indicators of a particular system or subsystem can be viewed by the operator from a single location on the process floor. Whenever possible this central location shall be the unit or system control panel or local control station.
3. Electronic instruments of a single system or subsystem shall have their indicators and transmitters grouped so as to facilitate calibration and viewing by personnel.
4. Unless otherwise specified, instrument enclosures shall be 316 SS or copper free cast aluminum construction. PVC coating shall be provided where severe corrosion is indicated.
5. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by manufacturer.
6. It is the purpose and intent of these Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, and the installation of instrumentation and controls shall be provided under this Contract.
7. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, orientation and dimensions of the connections and taps for instrumentation furnished under this Section are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation.
8. The Contractor shall coordinate panel and field instrumentation which are in the same control loop. These instruments shall be of the same manufacturer and/or shall be fully matched.
9. Panel mounted instruments such as loop controllers shall be provided with a slide out chassis.
10. Instruments and controls shall contain no mercury in any quantity for any purpose.

B. Location

1. Instrument locations indicated on drawings are diagrammatic. Actual locations shall be as close to the drawing locations as possible, in

accordance with the manufacturer's recommendations, field verified and approved by the Engineer.

2. Location and mounting detail drawings for all equipment shall be submitted to the Engineer for review and approval prior to any work commencing.

3. Transmitters, electronic indicators, etc. and any device requiring routine maintenance shall be wall or stand mounted at between 4-1/2 and 5 feet above finished floor with connections to process as required.

4. Equipment shall be installed in locations approved by the Engineer and out of the way of potential damage. Items shall be installed so as to provide ease of maintenance and operation. Equipment shall not be installed where it impedes access or egress within an area. In addition, the installation shall not block or impede maintenance or operational access to other equipment.

5. Instruments and indicators shall be installed and oriented to allow the operator or service personnel to read the device while at the local control location of the associated equipment. When no local control location is provided, a central location at the equipment shall be chosen by the Engineer. All indicators and readouts shall be located so as to be readable from the process floor.

C. Mounting

1. All instruments and equipment shall be securely and rigidly supported and mounted. Equipment shall be supported by structural members and not from other equipment or systems. When instruments such as gauges and switches are supported by pipe nipples, the pipe size shall be 1/2 inch minimum to the process pipe. Where shown on the drawings, mounting details shall be followed. All equipment specified under this Section shall be installed per the Contract Documents, manufacturer's recommendations and standard industry practice. When installation methods are not shown or specified, the manufacturer's recommendations shall be used after review and approval by the Engineer. All mounting and supporting hardware and appurtenances shall be furnished and installed under this Contract.

2. Where process taps or an instrument are located more than 10 feet above finished floor, or where subject to severe or damaging vibration, instruments, both electronic and non-electronic, shall be wall or stand mounted at eye level and tubing or capillary run to the process tap. With the approval of the Engineer, pressure gauges and thermometers mounted between 10 and 20 feet above the floor shall be provided in an 8 inch size rather than having remote tubing connections.

3. When pressure gauges are mounted at 6 feet or more above the finished floor, elbows shall be used as needed to articulate gauges and indicators at a 45 degree angle to provide easy viewing from the floor.

4. Instruments requiring calibration shall not be mounted more than 8 feet above the floor or their access platform. Such instruments shall be remote mounted and tubed or connected with armored capillary as appropriate, and mounted at eye level.

5. Pressure transmitters, differential pressure indicators (gauges) and transmitters shall be wall or stand mounted and tubing run to the process taps.

6. Field instruments mounted outdoors shall be mounted in thermal insulated enclosures fitted with thermostatically controlled space heaters to suit the environment. The front door of enclosure shall have a glass window to allow easy viewing of the indicator.

D. Process Connections

1. Instrument connections shall be oriented to provide optimal sensing conditions and eliminate transmission and entrapment of air, condensate, grit, particles, moisture, etc.

2. Instruments mounted in plastic, ductile iron or lined pipe shall be flanged (2 inch minimum) and provided with isolation valves. Instrument connections to vessels shall be flanged and provided with isolation means.

3. Temperature sensing elements for insertion into process piping and vessels shall be provided with a 3/4 inch NPT (minimum) stainless steel thermowell. Thermo-wells shall be provided for each temperature measurement system (thermometer, temperature switch, RTD, etc.) and shall comply with SAMA RC17 10. The probe and thermo-well insertion depth ("U" dimension) shall be selected to place the tip of the probe as near the center of the pipe or vessel as possible. Industry standard insertion depths shall be used when at all possible. Extended lagging type units shall be provided on all insulated vessels or pipes.

4. Armored capillary lines shall be furnished and installed on all remote mounted temperature indicators. The capillary shall be securely attached to walls or columns and secured with straps and screws at a spacing not to exceed 3 feet and within 18 inches of the devices. Bends, if required shall have the proper radius and shall be squared off. The tubing shall be run parallel or perpendicular to piping and other surfaces.

5. All process taps for pressure instruments shall have an isolation valve located as close to the point of process connection as possible and at the instrument. Valves shall be bolted three piece ball type with 316 stainless steel body and parts. Valves shall be 1/2 inch for clean service and 1 inch for dirty service.

6. When remote connected by tubing to the process tap, the connecting tubing shall be ASTM A269 316L seamless stainless steel with "Swagelok" type flareless fittings, 1/2 inch OD minimum for clean service and 3/4 inch OD for dirty service (effluent water etc.). Tubing and capillaries shall be secured over their entire length. Tubing shall be field bent using proper tools with fittings only being used where necessary. Rippled, kinked or flattened bends will be rejected and shall be discarded. Tubing shall be run neatly, squarely and parallel with or perpendicular to piping and structures. One half inch stainless steel ball valves shall be provided at both ends of the tubing. Valved flushing/calibration connections shall also be provided. Tubing shall be pitched to eliminate air or condensate from the lines. A "dirt leg" with a clean out valve and plug shall be installed directly below the point where the instrument is connected to the tubing

7. Pipeline and vessel mounted instruments shall have a stainless steel three piece coupling /union mount to allow removal from the process for calibration and testing without opening the process or disconnecting the electrical conduit or wire.

8. Differential pressure devices shall be provided with an factory mounted integral three valve calibration manifold in addition to the other required valving. When a factory mounted unit is not made, a field fabricated unit shall be constructed. Prior written approval of the unit shall be required.

9. Where vibration may be present, instruments shall be wall or stand mounted and tubing or capillary run to the process. If mercury type switches are to be used they must be securely mounted and isolated from movement and vibration.

E. Electrical Requirements

1. Instruments requiring electrical power or signal connections shall have sufficient length of flexible conduit and wire to allow easy removal without disconnection from the system. Flexible connections shall be a minimum of 12 inches and a maximum of 24 inches long unless otherwise approved by the Engineer in writing.

2. Electrical connections of wires to instruments shall be by screw terminal. When an instrument or device's terminals will not accept a #12 awg control or power wire, or when factory installed pigtails are provided, a suitable junction box, in accordance with Division 16 and area classification, shall be furnished and installed with and connected to the instrument.

3. All instruments requiring 120 Vac power shall be supplied with an external power disconnect switch and surge suppressor. The switch and suppressor shall be rated NEMA 4X and fabricated of stainless steel. Under this Contract the instrument shall be connected to the switch and isolator using

3/4 inch liquid tight flexible metal conduit and #12 awg conductors. In hazardous areas all work shall comply with the NEC and electrical specifications. Coordinate all installations with electrical installer.

F. Heat Tracing and/or Insulation

1. Heat tracing and insulation shall be provided when there is possibility of process fluid freezing or setting up. Refer to Contract Drawings for heat tracing details.

2. Instrument tubing in unheated areas or buildings shall be protected against freezing or setting up by insulation and heat tracing.

3. Any instrument, process pipe and tubing containing a non-flowing fluid which will precipitate at ambient temperature or has freezing point above ambient temperature shall be heat traced and insulated.

4. Any instruments close coupled to insulated and/or heated process pipe or equipment shall also be insulated and/or traced.

5. Pressure gauges used in services where freezing or setting up is a problem shall be equipped with diaphragm seals. Pressure switches, pressure, and differential pressure transmitters shall also be so connected in similar situations.

6. In case of filled type temperature instruments, the filling fluid shall be selected such that no heat tracing or insulation is required for the capillaries.

3.03 FIELD TESTING / QUALITY CONTROL

A. General

1. The Contractor shall, through the services of the HCS Supplier, comply with the requirements of Specification 23 09 15 – Instrumentation and Controls System Testing, Installation and Startup for all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein.

2. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

3. The HCS Supplier shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer

performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the City. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

4. At least 60 days before the anticipated initiation of installation testing, the Contractor shall electronically submit to the Engineer of the detailed description of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

5.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Field Instrument Calibration Requirements

1. The HCS Supplier shall provide the services of factory trained instrument technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by NIST (National Institute of Standards and Technology).

3. The HCS Supplier shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposal calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over voltages, incorrect voltages, over pressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the City.

6. After completion of instrumentation installation, the HCS Supplier shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all Contractor representatives involved for each loop test and witnessing Engineer.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place in satisfactory operating condition, control panels, equipment enclosures and associated devices as indicated in the Specifications, and as shown on the Contract Drawings. The term enclosures shall apply to both equipment enclosures and control panel enclosures. All control panels and equipment enclosures shall be designed, assembled, and furnished by the Heating and Ventilating Control Systems Supplier (HCS Supplier). The equipment shall be installed by the Contractor in accordance with the Specifications, manufacturer's recommendations, Contract Drawings, and best industry practice, together with all wiring, terminations, etc. to interface all instrumentation and controls, as required. Panels and enclosures shall be installed under the direct supervision of the HCS Supplier. Mounting equipment such as brackets, stands, hardware and appurtenances shall be provided as required.

B. This section includes:

1. Requirements for all control panels and equipment enclosures housing control and instrumentation equipment, PLC, wiring, terminals, etc.
2. Control Panel Fabrication.
3. Equipment Enclosures.
4. Control Panel Equipment and Devices.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 09 00 - Instrumentation and Controls Scope and General Requirements for HVAC.

B. Section 23 09 13 - Instruments and Control Devices for HVAC.

C. Section 23 09 14 – Control Panel, Enclosures and Devices for HVAC.

D. Section 23 09 15- Instrumentation and Controls System Testing Installation and Startup for HVAC.

E. Section 23 05 93 - Testing, Balancing and Adjusting.

1.04 REFERENCES

A. All equipment and services provided herein shall be in accordance with the references stated in the Specification 23 09 00 – Instrumentation and Controls Scope

1.05 DESCRIPTION

A. Not used.

1.06 QUALITY ASSURANCE

A. Not used.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

a. Equipment Specifications and data sheets identifying all materials used and methods of fabrication.

b. Complete assembly, layout, installation and foundation drawings with clearly marked dimensions

c. Detailed fabrication drawings of all equipment provided under this Section. Drawings shall show materials; all dimensions both internal and external; internal equipment layout, dimensions and spacing; power input and wiring terminal locations; mounting location, heights, finishes and installation details.

d. Detailed data sheets, installation manuals, instruction and operation manuals, manufacturers literature, options and all other pertinent information for all equipment provided under this Section.

e. Complete schematic wiring diagrams and internal point to point wiring diagrams for all units.

f. Factory and field testing procedures and certified results.

2. Informational Submittals:

a. Spare Parts List.

b. Special Tools List.

c. Reports of Certified Shop Tests.

d. List of Lubricants.

1) The manufacturer shall submit a list with a minimum of four (4) manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation, and packing of the control panels, enclosures, and devices for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The control panels, enclosures, and devices shall be handled in such a manner that they may be transported and unloaded without being over-stressed, deformed, or otherwise damaged.

2. The control panels, enclosures, and devices shall be protected from corrosion and deterioration and shall be stored in a dry area.

a. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with effective and durable waterproof covers approved by the Engineer.

C. Interiors shall be kept free from dirt and foreign matter.

D. Each panel shall be identified with purchaser's complete order number and tag number on a metal tag securely wired to the panel. Each component requiring identification for proper assembly shall be tagged separately.

E. Panel shall be so packaged and packed that, with customary handling; it will be protected from damage in shipment. Each shipping section shall be mounted on skids.

F. Before packing, all equipment shall be clean and dry.

G. All electrical wiring leads between panel sections shall be clearly marked for reassembly and shall be coiled and rigidly held within the panel framework.

H. Special handling instructions shall be conspicuously placed on all equipment requiring unusual handling and shipping care.

I. In general, standard panel instruments such as indicators, which can be damaged during transit shall be removed and shipped separately.

J. When equipment is transported to the Site by ship, the following shall apply:

1. All equipment shall be shipped as below deck cargo.

2. Whenever practicable, panels shall be bolted to container frames. All exposed tubing, wiring, and instruments shall be protected by padding. Containers shall be lined with water proofing materials.

3. Instruments shipped separately shall be packed in moisture-proof containers with a desiccant and held in a fixed position with packing.

4. Crates and boxes shall be reinforced with steel straps. Crates and boxes with a net weight in excess of 400 lbs. shall have diagonal bracing on all faces. When net weight is in excess of 500 lbs., skids shall be bolted to the container frames.

K. All equipment, once assembled, whether stored at the factory, on Site or at a remote location, shall be kept protected and free from damaging environmental conditions. Unless otherwise specified, equipment shall be kept in a dry, dust free, temperature-controlled area, free from temperature and humidity fluctuations, and in accordance with the equipment manufacturer’s recommendations. As a minimum, temperature shall be kept above 55 degrees F and no condensation shall occur.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Provide all of the individual manufacturers recommended spare parts and tools for all equipment specified herein. In addition to the recommended spares, furnish all of the following minimum spare parts, tools and devices.

1. General

a. 20% (minimum of 10) spare fuses, lamps for indicating lights, etc., for each size and type provided.

2. Relays, Circuit Breakers, Fuse Holders, etc.

a. 10% (minimum of 2) spares of each size, type and configuration for each 10 or part thereof installed.

3. Panel Mounted Switches, Push Buttons and Indicating Lights

a. 10% (minimum of 2) spares of each size, type, color and configuration for each 10 or part thereof installed including contact sets).

4. Terminals and Mounting Strips

a. 20% (minimum of 10) spares of each size, type and configuration for each 10 or part thereof installed (including mounting rail).

5. Specialty Items Not Listed

a. 10% (minimum of 2) spares of each size, type and configuration for each 10 or part thereof installed.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. General:

1. The Contractor shall furnish and install control panels and enclosures to house all instrument, control and electronic equipment, wiring, terminals and accessories. Control panels and enclosures shall be assembled, wired, and tested in the HCS Supplier's own or other Engineer/City approved facility of his choosing. All components and all necessary accessories such as power supplies, power conditioning equipment, mounting hardware, input and output terminal blocks, plug strips, relays, lighting, circuit breakers, fuses, etc., which may be required to complete the system shall be

provided. Internal layout and internal point to point wiring for typical panels shall be identical.

2. Unless otherwise indicated, panels, enclosures and all exposed panel mounted devices, shall have a minimum of a NEMA 4X rating. Enclosures shall be formed or welded construction reinforced with Unistrut, Powerstrut, or approved equal to stiffen panels and doors and facilitate mounting of internal components or equipment. Enclosures shall be 16 USS gauge for units with all dimensions 24 inches or less, 14 USS gauge for units with all dimension greater than 24 inches and less than 48 inches. Enclosures with any dimension of 48 inches or more shall be 12 USS gauge. All floor mounted units shall be 12 USS gauge and shall be provided with jackscrews for leveling. For large and floor standing panels, each shipping section shall be provided with four removable lifting lugs.

3. Doors shall be formed, with welded continuous hinged swing type with the hinge running vertically. Door swing shall be a minimum of 165 degrees. Door closure hardware on NEMA 12 units shall be a three point closure system with single external lockable handle. Multiple clamp type closure is acceptable for small enclosures containing only terminals or non maintenance items. NEMA 4 and 4X units shall have multiple clamp type closures on three sides of the door with padlock accessories and locks. Sufficient doors and access panels shall be provided to facilitate maintenance and testing of the supplier's equipment. All doors shall be fitted with common keyed locks. The door edges and panel opening shall be rolled to prevent the entrance of water and debris when panels are opened.

4. The use of prefabricated, standard "Hoffman" type industrial enclosures is acceptable. The enclosures shall be purchased factory finished as required herein.

5. Provide additional stiffeners or separate mounting panels for OIT units mounted in panels.

6. Steel members shall be provided in the back of the panel for rigidity and support of wiring, accessories, etc. Stiffeners shall be welded to the back face of the panel where required. Stiffeners shall not interfere with instrument installations and weld marks/discoloring shall not be visible. Sufficient stiffeners and/or supports shall be provided so that the panel face does not distort due to the weight of the instruments or equipment.

7. All equipment and devices shall be identified with engraved nameplates both inside and out. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted and gasketed, with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating.

8. The Contract Drawings show approximate dimensions of control panels and preferred front layout. The Contractor shall be responsible for detailed design of all control panels and enclosures. All panels and enclosures shall have a minimum of 6 inches of clear perimeter gutter space from internal equipment (including terminal strips and wireway) to the enclosure wall. Enclosures with a dimension greater than 36 inches shall have a minimum of 12 inches clear gutter space. Panel enclosures shall not be crowded. Ample space shall be provided between components to allow for heat dissipation and servicing. The internal components shall be arranged such that they can be serviced without removing other components.

9. All control panels shall have a single power supply entry point and a power disconnect switch. Control devices shall be mounted in functional groups in accordance with good panel design practice so as to present a neat and functional appearance and so as to be readily identifiable and accessible for adjustment and service. The panel arrangement shall be approved by the Engineer.

10. All panels and enclosures shall have sub plates and sub panels for mounting equipment. These shall be USS gauge #10 minimum and painted gloss white. A bonding jumper to the enclosure, of #10 AWG copper wire or braid shall be provided.

11. Cut outs shall be made, without distorting the face of the panel, to the dimensions and tolerances specified on the instrument manufacturer's certified drawings. Cutouts shall be saw cut or punched smooth and straight, or round as required, parallel to the panel sides and ground smooth and free from burrs. Flame cutting will not be accepted. Both the front and back surfaces of the panel face near the cut outs shall be level to permit proper instrument installation.

12. Panels shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING This Device Is Connected to Multiple Sources of Power". Letters shall be 1/2 inch high, white.

13. Floor mounted panels shall be free standing, requiring no external bracing or support. Angle Iron framing shall be provided at the bottom part of each panel. The framing shall be box construction, with all corners fully welded, and shall be reinforced with additional members as required to prevent buckling or distortion of the frame or the panel face due to normal handling during transportation and final assembly. The bottom 12 inches of floor mounted panels shall have no equipment or terminals located there.

14. The rack framework shall be welded steel construction 1 5/8 x 5/8 inch using Powerstrut, Unistrut, or approved equal and/or angle iron to provide a rigid assembly. Racks shall be of open, box like framework with all frame supports welded and ground smooth. Steel straps shall be used for locating

terminal blocks. The terminal blocks shall be factory assembled on a miniature mounting channel and the channel bolted to the steel strap.

15. The joints at the bottom of the panel shall be even and flat to within 1/16 inch. Care shall be taken that the weight of each section is carried by the framework, and not by the bottom edge of the panel face.

16. Panels, which are mounted on concrete slab, shall be furnished with base bolt holes at the channel base for use in anchoring the panel to the slab. Removable lifting lugs shall be provided at the top of each panel. All mounting hardware and anchors shall be of 316 stainless steel.

17. Floor standing panels shall have solid bottoms. Panels in control rooms shall have all wireways brought directly into the panel bottom.

18. All panels and enclosures shall be provided with a steel pocket for keeping drawings. One extra set of the as built drawings shall be provided and kept in the panel.

B. Enclosures Materials, Temperature Control, and Area Classification:

1. Enclosures for outdoor service shall be 304 SS NEMA 4X weatherproof construction with clear polycarbonate framed window in hinged and gasketed door to permit full view of all enclosed instrumentation and/or controls without opening. All doors shall be fitted with common keyed locks. Panels shall be suitable for wall or pipe mounting. Panels shall be insulated and equipped with thermostatically controlled internal space heaters for severe winter service. Heaters shall maintain 50 degree F interior temperature at a 0 degree F ambient temperature. Fiber glass enclosures will not be accepted.

2. Enclosures located inside electrical equipment rooms, administrative areas or air conditioned control rooms in non contaminated areas as well as floor standing panels containing an OIT, shall have a minimum of a NEMA 12 rating and shall be corrosion resistant. Corrosion resistant enclosures shall be made of 316 SS, or steel, coated with a powdered resin which is heat-cured 100% solid thermosetting epoxy.

3. Enclosures used in all other areas, except hazardous locations, shall be rated NEMA 4X and shall be fabricated out of 316L stainless steel unless otherwise indicated. All the devices and hardware on the front of NEMA 4X rated panels will be specifically NEMA 4X rated. Splash-proof equipment and hardware shall not be acceptable for mounting on NEMA 4X panels. All enclosures shall include sealed gasketed doors to protect internal equipment from outside air.

4. All enclosures containing heat generating equipment shall include integrally mounted fans to circulate the air within the enclosure and remove heat from the modules. Enclosures and doors shall be designed to dissipate heat

through their exterior surfaces into the plant environment. Air shall not be exchanged between the enclosure's interior and the outside environment. Alternatively, cooling air can be drawn from non-contaminated area.

5. Enclosures and panels located in areas where chlorine liquids or gasses are handled stored or transported, shall be fabricated out of a material suitable for use in such an atmosphere. Material selection shall be approved by the Engineer.

6. Panels and enclosures located in areas required to be or indicated as hazardous shall be constructed to NEMA 7 standards, shall be UL approved for that application and shall be rated for the atmosphere in which they shall be installed. The units shall be rated Class I Division 1 Group D as a minimum. All such panels shall be finished with powder coated thermosetting epoxy resin for corrosion resistance or PVC coated when required. All external devices shall be rated for the application and shall be corrosion resistant.

C. Control, Selector and Push Button Switches

1. Switches and push-button type operators shall be rated for the enclosure in which they are mounted. As a minimum, all devices shall be NEMA 12 and 13, oil and water tight. Switches and operators mounted in NEMA 4X panels shall have a NEMA 4X rating. All operators used on the Project shall be from one manufacturer and shall be the same line.

2. Devices shall be of the 30.5 mm type rated for extra heavy duty service.

3. Selector switches shall have gloved hand operating handles.

4. Push buttons shall be of the guarded type except those being used for stop control.

5. Emergency stop push buttons shall be Push - Pull type with maintained contacts.

6. Control and selector switches for control of 5 KV equipment and circuit breakers shall be switchgear duty control switches General Electric SB1, SBM or approved equal. Circuit Breaker trip control switches shall have 2 parallel contacts. Close switches shall have 2 series contacts. Normal after close and normal after trip contacts shall be provided.

7. Control switches, selector switches, push buttons, etc. for use in explosion proof (NEMA 7) panels and/or equipment located in hazardous areas shall be rated explosion proof for use in Class 1 Division 1 atmospheres.

D. Indicating Lights

1. Indicating lights shall be 120 volt transformer type, with replaceable high intensity L.E.D. type lamp, unless otherwise noted.

2. Indicating lights shall be rated for the enclosure in which they are mounted. As a minimum, all devices shall be NEMA 12 and 13, oil and water tight. Indicating lights mounted in NEMA 4X panels shall have a NEMA 4X rating. All indicating lights used on the Project shall be from the same manufacturer as the operators specified above and shall be the same line.

3. Devices shall be of the 30.5 mm type rated for extra heavy duty service.

4. Indicating lights shall be push to test type. The push to test feature shall not interact with any other circuitry.

5. Indicating lights for use in explosion proof (NEMA 7) panels and/or equipment located in hazardous areas shall be rated explosion proof for use in Class 1 Division 1 atmospheres and shall be push to test type.

E. Relays

1. General purpose control relays shall be the socket mounted type for DIN rail mounting. Relays shall be tube socket or quick connect square base type. Miniature relays are not acceptable. Each relay shall have a minimum of two or three single pole double throw contacts each rated 5 or 10 amps as required. The relays shall have a push to test feature and a coil indicating light. Potter & Brumfield KRP, KUP, or approved equal

2. Relays used for control of motors shall have a horsepower rating above that of the connected motor at the appropriate voltage. Motor overload protection shall be provided.

3. Relays used for emergency shutdown and safety circuits, those common to several pieces of equipment and all relays associated with control or monitoring of 5 KV equipment shall be 4 pole (min.) 600 volt machine tool type. Contacts shall be convertible type with a 10 amp minimum ratings. These units shall be Allen-Bradley class 700 P, or approved equal.

4. Relays used for control of 5 KV or higher circuit breakers shall be utility grade switchgear control relays having the proper AC and DC ratings. These units shall be General Electric type HGA, HFA, or approved equal.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not used.

2.05 ELECTRICAL REQUIREMENTS

A. All control panels and enclosures shall be powered by 120 VAC unless otherwise specified. UPS protection shall be provided as indicated and will be supplied under this Contract.

B. The wiring terminals shall be rail mount, screw type lift plate or suitable for solderless horseshoe connectors and rated at least 20 amps at 600 volts. The screws for solderless terminals shall be # 8 minimum. They shall be marked with a permanent, continuous marking strip from end to end with the numbers appearing on the approved shop drawings. One side of each terminal strip shall be reserved exclusively for field wiring. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer/City, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable. Terminals for field wires shall be provided in an easily accessible area of the panel.

C. Terminal blocks for current transformer circuits shall be the shorting type. Shorting terminal blocks shall be provided for all C.T. circuits when entering or leaving the panel.

D. Wiring shall comply with accepted standard instrumentation and electrical practices. For each pair of parallel terminal blocks, the field wiring shall be between the blocks. Lift plate or box type terminals shall be used for connecting wires to terminal blocks. Solderless horseshoe connectors with insulating sleeves and # 8 bolt hole shall also be acceptable. The terminals for field wiring shall be properly sized UL approved to accept field wires of #12 gauge. Fused terminal blocks of the same style shall be used for all output connections to field devices.

E. All wiring shall be enclosed in vented plastic wireway with covers. Wireways shall not be filled to more than 40% of capacity. Where wireway is not possible, conductors shall be run open and shall be bundled and bound at regular intervals, not exceeding 6 inches with nylon cable ties. The bundles shall be secured at intervals not to exceed 12 inches. Care shall be taken to separate electronic signal, discrete signal, and power wiring. Where wiring crosses on to a hinged panel, the wiring shall be bundled and run vertically along the hinge as long as possible to better distribute the twisting forces. The bundle shall be secured at both ends to the panels.

F. Interior panel wiring and field wiring shall be color coded and tagged at all terminations and devices with machine printed plastic sleeves. The wire number shall be as indicated on the approved shop drawings.

G. All incoming and outgoing wiring shall terminate on panel terminal blocks unless approved otherwise in writing by the Engineer. The System Supplier shall furnish all wiring between panel mounted instruments and the terminal blocks. Terminal blocks shall be rated at least 600 volts, 20A, Square D Type G, or approved equal.

H. At shipping joints, interpanel wiring shall be completely installed, terminated with terminals, identified, factory tested and then coiled back for shipping.

I. All wiring to devices mounted on enclosure doors shall be extra flexible and enough slack must be provided to prevent any tension when doors are at maximum opening. Wiring bundles run from panels to doors shall be run lengthwise along the hinge to

spread the opening torque along the greatest length of cable. Permanent cable anchors shall be provided at both ends of the cable to eliminate any torque being applied to wiring terminals.

J. All wire mounts shall be either Epoxy glued or screwed to the equipment mounting plate. Screws shall not penetrate the enclosure. Stick on or self sticking wire mounts will not be acceptable.

K. For incoming wiring provide enclosed wiring troughs in the panel reserved for incoming field wires and wireways from the troughs direct to instrument terminals. Provide these troughs at bottom of panel if incoming wiring is from below.

L. Terminal block layout shall be such as to provide ample access to wiring during installation, checkout, and maintenance. Minimum spacing between adjacent terminal blocks and/or panel edge shall be 6 inches. A minimum of 6 inches space shall be provided at the top and bottom of panels and enclosures.

M. Duplicate terminals shall be provided on the panel for common field wires (such as annunciator common, AC power leads, neutrals, etc.) to limit the maximum number of wires on a terminal to two. Spare terminals equal to not less than 25% of the required points shall be furnished. Jumpers if required shall be connected to the panel manufacturer's side of the terminal blocks.

N. All incompatible circuits (such as low level signals) shall be separated from power circuits and/or each other with separate slotted wireway and junction boxes.

O. Wire for 120 Volt, 60 Hz control circuits shall be minimum No. 14 AWG stranded copper, NEC type MTW/THHN with 600 Volt insulation, and minimum 90 degree C rating. AC power wiring shall be 12AWG minimum. Internal wiring for panels controlling 4160 volt equipment, main pumps, blowers, switchgear. etc. shall be wired using 14 AWG tinned copper SIS wire. Wiring for current transformer circuits shall be 10 AWG tinned copper SIS and shall be yellow. Wiring for potential transformer circuits shall be 12 AWG SIS.

P. Wire for 24 volt DC Signals shall be minimum No. 16 AWG stranded tinned copper, shielded twisted pairs. Where terminated or connected, the end of the jacket and shield shall be sealed with heat shrink tubing.

Q. All AC and DC control and power wiring as well as all signal wiring, shall be tagged on both ends. Where Contract Documents have not specified wire numbers, the wire numbering scheme from the approved shop drawings shall be used. Terminals on panel terminal blocks shall be identified with a terminal block number and terminals shall be in sequential order.

R. Instrument transmission and control wires and associated panel terminal shall be identified with the instrument tag number, function, and polarity.

S. Indicating lights color shall be as follows:

Color	Function

Red	Running, Breaker Closed
Amber (flashing)	Alarm
Green	Ready, Breaker Open, Valve Closed
White	Control Power On
Blue	Valve Open

T. Where indicated or required by codes, all panels and panel mounted equipment shall be explosion proof.

2.06 POWER DISTRIBUTION

A. Electrical power shall be distributed throughout the panel and field instrumentation requiring 120 VAC, 60 Hz, by means of a power distribution panel or individual fuses. There shall be a common power disconnect switch.

B. The number of circuit breakers or fuses shall depend upon the process functional requirements. The circuit breakers shall be arranged in neat functional groups so that an overload or short circuit inside the panel shall disable only a part of the process. As a minimum, circuits pertaining to one piece of equipment shall be fused or protected separately to allow servicing of that piece of equipment without affecting others.

C. Surge protectors and power conditioners shall be provided for all electronic equipment located inside the panel. To provide protected power at a level that is safe for all connected equipment.

D. An additional 120 vac duplex receptacle shall be provided in any panel or enclosure which contains equipment that requires programming or calibration. This shall be for powering laptop computers and test equipment only.

2.07 LIGTHING

A. Panels with any dimension 48 inch or greater or a depth in excess of 12 inch shall have internal lighting. Fluorescent lighting shall be used unless it will have a detrimental effect on enclosed equipment. A SPST toggle switch or door actuated switch and lighting fixtures with lamps shall be provided as required to illuminate the entire panel interior.

2.08 GROUNDING

A. Each panel mounted device shall be bonded or otherwise grounded to the subpanel on which it is mounted by means of machine threaded screws with locknuts, lock washers or other pressure mounting methods.

B. Each panel shall be provided with at least two copper ground busses, one for AC instrument power (normally 115 VAC 60 Hz) grounds and one for DC signal grounds. The DC ground bus must be electrically isolated from the panel board.

C. The DC ground bus shall be connected to a remote grounding rod by means of an independently run #2 AWG insulated copper ground wire.

D. Ground busses shall be minimum 1/4 inch x 1 inch x 8 inch with two (#2/0) AWG lugs for connection to plant grounding system. These grounding busses shall be predrilled for connection of instrument, panelboard, or cable shield connection.

E. When panel or field wiring for electronic instruments is specified shielded, a shield terminal shall be provided for each control loop at the terminal strip connection to and from field instruments. Shields shall be connected through the field terminal strip and continued to the equipment connection. Each shield shall be grounded at one point only, and this ground connected to the DC ground bus in the panels or as required by the equipment manufacturer.

F. Subpanels for mounting of internal equipment, enclosure doors and all internal metal objects shall be grounded by means of a #10 AWG bonding jumper.

2.09 CONTROL LOGIC

A. Control logic shall be performed using relays and/or PLCs as indicated and required. When not so indicated, logic shall be performed using hardwired relay logic.

B. Emergency and safety controls, etc. shall be implemented using hard wired relay logic. Relays for these functions shall be 600 volt machine tool type. These systems shall include but not be limited to:

1. HVAC Fire Alarm Interlock

C. The control logic for fan/damper control, stop/start operation of rooftop units, heating and ventilating units, dehumidification units, Supply and Exhaust fans shall be implemented using relay logic with PLC monitoring where indicated.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not used.

3.02 INSTALLATION

A. All panels and enclosures shall be mounted straight, level and parallel to building surfaces.

B. Wall mounted panels and enclosures shall be securely mounted to walls or columns as indicated. They shall be spaced a minimum of 3/4 inch from the structure using strut or plates.

C. Stand mounted units shall be supported using steel channel securely mounted to the floor with a minimum of four 1/2 inch stainless steel bolts. Stands shall be secure and level, shall easily support the mounted equipment and shall hold the equipment rigidly.

D. All free standing control panels shall be installed on a 6 inch wide and 4 inch high reinforced concrete curb with chamfered corners. The curb shall be 1 inch larger than the panel on all sides.

E. When panels or enclosures are installed on raised grating floors, additional supports and bracing shall be provided under the floor as required to prevent the floor from being overloaded. Large and/or heavy panels having any dimension larger than 72 inches or weighing 300 lbs or more or where the weight of the completed panel exceeds 80% of the specified load bearing capacity of the flooring, shall be supported from the structural sub floor independently of the raised floor. Provide a welded steel support framework the size of the unit footprint capable of rigidly supporting the weight of the entire panel with a 50% safety factor. The floor system shall be installed flush and level with this frame. Load and bracing calculations shall be submitted for review.

F. The Contractor shall comply with manufacturer stated floor installation requirements. In areas where floor modifications are required, and the floor has already been installed, the Contractor shall retain the services of an approved flooring subcontractor to make the appropriate modifications at no additional cost to the City.

3.03 FIELD TESTING / QUALITY CONTROL

A. All control panels and enclosures provided under this Contract shall be factory and field tested in accordance with Sections 23 09 15 – Instrumentation and Controls System Testing, Installation and Start-up for HVAC.

3.04 STARTUP / DEMONSTRATION

A. Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not used.

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 23 09 15 – INSTRUMENTATION AND CONTROLS SYSTEM TESTING, INSTALLATION AND STARTUP FOR HVAC
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall test all equipment provided under this Contract, in accordance with Specification 01 75 10 - Preliminary and Final Field Tests, all requirements of individual Specification Sections and as required herein. The Contractor shall retain the services of the Heating, Ventilating and Air Conditioning Control Systems Supplier (HCS Supplier) to furnish labor, supervision, materials, equipment and incidentals as required to properly install, thoroughly test and startup the HCS as required herein

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Specification Section 23 09 00 - Instrumentation and Controls, Scope and General Requirements for HVAC.

B. Specification Section 23 09 13 – Instrumentation and Control Devices for HVAC.

C. Specification Section 23 09 14 – Control Panels, Enclosures, and Devices for HVAC.

D. Specification Section 23 09 93 – Sequence of Operation for HVAC.

1.04 REFERENCES

A. All equipment and services provided herein shall be in accordance with the references stated in the Specification 23 09 00 - Instrumentation and Controls - Scope and General Requirements for HVAC.

1.05 DESCRIPTION

A. The Contractor shall retain the services of the HCS Supplier to perform the following functions:

1. Select all equipment, perform a detailed design, provide all Shop Drawings and coordinate integration of the entire HVAC control systems.

2. Perform a comprehensive integrated system factory test of all components, hardware and software at his manufacturing facility prior to shipment of any equipment to the Site.

3. Direct and supervise the installation, mounting, connecting, piping and wiring of all field, panel and control room instrumentation, controls and computer equipment and test same per the Contract Documents, manufacturers' recommendations and best industry practice.

4. Perform field testing and calibration of all equipment provided, in accordance with the Contract Documents and as recommended by the manufacturers and specified reference standards.

5. Participate in and perform startup activities on all equipment provided as part of the Contract, participate and assist in startup and testing of all equipment monitored and controlled by his system.

1.06 QUALITY ASSURANCE

A. All testing, installation and startup duties shall be performed by certified, well trained experienced personnel as required by Specification 23 09 00 -

Instrumentation and Controls Scope and General Requirements for HVAC and shall be directly supervised by the Project Engineer.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for all equipment and Work provided, for the approval of the Engineer in accordance with Specification 01 33 00 – Submittal Procedures.

B. Complete system installation and layout drawings of all equipment shall be submitted to the Engineer for approval. Layout drawings shall reference the same areas as the Contract Drawings but shall indicate actual proposed locations, heights and orientation of all equipment.

C. Installation and mounting details based on actual equipment shall be submitted for approval on all items. These shall include weights, dimensions, orientation, and method of mounting and special considerations or requirements.

D. Prior to commencing any testing, the Contractor shall submit complete and detailed test procedures for all testing required. All testing submittals are to be reviewed by the Engineer for approval. Proposed log sheets and report formats containing all information to be recorded and results of all tests shall be included in the submittal. Test procedures shall be submitted early enough to be approved at least 30 Days prior to testing.

E. Prior to acceptance of any equipment for operation by the City, all reports of satisfactorily completed tests shall be approved. Any waiver of this requirement must be in writing from the Engineer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not used.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not used.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not used.

2.02 MATERIALS / EQUIPMENT

A. Not used.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Factory Testing

1. When Shop Drawing review of all pertinent items is completed and equipment has been procured, fabricated, programmed and assembled and prior to shipment of any equipment to the Site, a fully integrated Factory System Test shall be performed at the HCS Supplier's facility. When the factory tests have been successfully completed, a certified copy of all test results shall be furnished to the City together with a clear and unequivocal statement that all factory test requirements have been met.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Simulators and test equipment may be used for Preliminary Field Testing but actual field and process conditions shall be used for Final Testing unless waived in writing by the Engineer.

3.02 INSTALLATION

A. Upon successful completion of all factory testing and remediation of any outstanding items, the Contractor shall begin field installation of the components of the HCS systems. Installation shall proceed in a timely and orderly fashion with all components being installed per the approved Shop Drawings and the Contract Documents. During installation, the Contractor shall perform its own tests on all completed equipment and systems to verify proper operation prior to field acceptance testing required by the Contract Documents.

B. The Contractor shall install all equipment in accordance with the Contract Documents, Working Drawings, manufacturers' recommendations, and best industry practice.

C. Equipment shall be installed level and plumb, parallel, or perpendicular to building structures, spaced from walls and at an elevation that will ease startup and system maintenance. When no installed height is given for instruments or controls, a centerline height of 60 inches shall be assumed. For control panels, the top of the panel enclosure shall not exceed a height of 78 inches nor shall any control devices or indicators be located above 72 inches or below 42 inches.

D. Equipment shall be mounted and secured so as to provide sound and rigid support, ease of maintenance and accurate and dependable operation.

E. All equipment associated with the HCS shall be installed by highly qualified personnel using the utmost care to provide a neat, highly functional, efficient and professional installation.

F. Electrical equipment, conduit system, wire, etc. shall be installed and tested in accordance with Division 26 of the specifications and the Contract Drawings.

3.03 FIELD TESTING / QUALITY CONTROL

A. Once a sufficient portion of the HCS has been installed and is operational as determined by the Engineer, the Contractor shall begin field testing of individual components and subsystems as they are completed. The Engineer reserves the right to witness all testing.

B. Preliminary field testing of an individual component may begin when the unit is properly installed and fully connected to the process.

C. Preliminary and Final Field testing of systems and subsystems shall only proceed when, in the opinion of the Engineer, the entire system under test has been completed and is operational. The Final Field Testing of control systems shall only be done when all controlled and driven equipment is operational and under system control. To be used in Final Field Testing of the HCS or subsystems, the term operational shall mean that the controlled and driven equipment and all associated items, (starter. etc.) have passed their own Preliminary and Final Field Tests.

D. Preliminary and Final Field tests required of the HCS and associated subsystems shall include but not be limited to:

1. Preliminary Field testing of systems including.
    a. Field Calibration of all instruments and controllers.
    b. Control panel field tests.
    c. Preliminary operational tests of control strategies and all system logic.
    d. Individual testing of equipment control systems with operational equipment. (Pumps, HVAC, etc.)
2. Final Field testing of systems including:
    a. Integrated system field test.
    b. System optimization and final tuning.

E. To achieve satisfactory completion of any test, approval of the Engineer in writing shall be required. Satisfactory completion of a test shall only be achieved when all components of the system under test are functioning properly and concurrently for a sustained period as required by Specification 01 75 10 - Preliminary and Final Field Tests.

F. Preliminary Field Testing

1. The Contractor shall perform Preliminary Field Testing for all equipment and systems provided as part of the HCS. All tests performed as part of the Factory Test shall also be performed as part of the Field Testing. The following is a minimum listing of procedures required to be completed for Preliminary Field Testing of the referenced equipment.

    a. Calibration

        1) All field instruments shall be factory calibrated and certified for the ranges required. Field verification shall be performed for all instruments prior to operation.

    b. Control Panel Testing

        1) Upon completion of all interconnecting wiring and control circuitry between the control panel, equipment, instrumentation, and related systems each control panel and equipment enclosure shall be subjected to a control panel installation test. Each panel shall be fully inspected and tested for function, operation, and continuity of all circuits between the control panel and all connected devices. Control strategies, equipment operation, logic, safety, interlock, and indication functions shall be verified. A log book shall be maintained by the Contractor for this purpose.

        2) Upon the satisfactory completion of all control panel installation tests, a certified report, including all test documentation, shall be furnished to the Engineer together with a clear and unequivocal statement that the installed panels have been successfully inspected and tested.

    c. Testing of Individual Equipment

        1) The Contractor is advised that the HCS and subsystems thereof will be required to be used as an integral part of field testing of other equipment. The Contractor is further advised that personnel of the HCS Supplier shall be required to participate in such testing to make their systems available in a manner suitable for testing of the devices under test. HCS signals shall be field calibrated and certified prior to use in testing of other equipment.

        2) Each piece of HVAC equipment, fan, etc. shall be fully tested with its subsystem of the HCS in order to satisfactorily complete its Final Field Test of Equipment. Such equipment shall be required to respond to HCS signals in order to comply with their Equipment Final Field Testing requirements. Satisfactory operation of all associated equipment and controls in accordance with the requirements

of Specification 01 75 10 – Preliminary and Final Field Tests shall complete testing for both parts of the system under test.

G. Final Field Testing

1. General

a. The Contractor shall perform Final Field Testing for all equipment and systems provided as part of the HCS. Final Field Testing of the HCS shall require that all Preliminary and Final Field Testing of all individual HVAC equipment items be completed, and the equipment be operational prior to commencing any tests. HVAC equipment, including air handlers, fans, etc. shall be operated by the system for all Final Field Testing.

2. Integrated System Field Test

a. The Contractor shall perform an Integrated System Field Test on the HCS as a complete system including all HVAC equipment (air handlers, fans, etc.).

b. Each piece of equipment shall be started and stopped both manually and automatically from Local Control Panels. Set points and sequences shall be changed, lead / lag systems tested and response documented. All normal process functions shall be tested.

3.04 STARTUP / DEMONSTRATION

A. General

1. Upon satisfactory completion of all testing, systems shall be started and brought on line to support and supply facility needs. The Engineer shall be notified 1 week prior to starting or bringing any system online for the first time and 2 Days prior on subsequent starts.

2. The Contractor shall retain the services of the HCS Supplier to provide highly qualified personnel to work along with DEP operators to finely tune all control loops; modify control algorithms, strategies and sequences; revise calculations and provide technical advice as required to bring the entire HCS systems to optimum performance and efficiency. Optimization and tuning hot water distribution and space heating systems will require that a real plant load be available. Seasonal timing may require that optimization and fine tuning of these systems may have to be done after acceptance of the equipment during the next heating season.

3. Equipment, strategies, and systems shall be fine-tuned to achieve:

a. Stable system operation at set point.

b. Timely delivery of required energy or product to loads.

c. System operation free from oscillation and error.

d. Minimized energy consumption.

e. Minimized cycling of equipment.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not used.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

The Contractor shall employ the services of the HCS supplier to provide all programming, controls and required items and services to furnish a system that enables the heating and ventilating systems and equipment to function properly and in accordance with the sequences and schedules specified herein and as indicated by the Contract Documents.

Process control functions shall be structured to permit the realization of all control strategy requirements. Where applicable, operator adjustable parameters shall be automatically defaulted to a preset value if a specific value is not given during system generation.

The following index of this Section is presented for convenience:

1.02 PAYMENT

No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

Specification Section 23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC.

Specification Section 23 09 13 – IC Devices for HVAC

1.04 REFERENCES

All equipment and services provided herein shall be in accordance with the references stated in the Specification 23 09 00 - Instrumentation and Controls - Scope and General Requirements for HVAC.

1.05 DESCRIPTION

This Section includes the intended sequences of operation / control strategies for the HVAC systems and the overall HVAC Control philosophy and requirements. In addition:

1. The basic HVAC control philosophy shall be as follows:
    a. As a minimum, the system shall permit the operator to run each system and piece of equipment in the following modes:
        1) Automatic: Control strategies shall be implemented generally by the designated control processors with minimal operator intervention.
        2) Local Manual: Plant shall be run by the operator by means of local field devices with full monitoring and alarming by the system.
2. Single point or single system failure shall not disable the plant or equipment operation.
3. All personnel safety and equipment protection interlocks and alarms shall be hardwired and active in all modes of operation.

Control Strategies – Definitions

4. The control strategies are written descriptions of the basic configuration and/or programming required to implement regulatory and sequential control of the unit processes as shown on the Control Diagrams and as stated herein. They do not in all cases describe the process characteristics fully, many of which may become apparent only during start up and testing. Any function blocks necessary to compensate for the process characteristics shall be provided and implemented as necessary until the Final Acceptance of the plant. Control strategies shall monitor the position of all switches

and the status and availability of all equipment under its control. Failure of a system or piece of equipment to operate as expected shall generate an alarm to the system.

Hardware

5. Control Diagrams show only the minimum necessary hardware. The HCS Supplier shall provide all the hardware, whether or not shown or specified, that may be necessary to implement the control strategies as described.

Configuration

6. All set points, tuning parameters and engineering units, ranges, etc., shall be documented for each control point and each control strategy on configuration sheets or similar documents. These documents shall be updated during factory testing and finally during start-up.

7. All set points, operating limits, time delays, alarm points, alarm conditions, etc. shall be fully adjustable, within an appropriate range from the local control panels whether specified or not.

8. Control strategy implementation shall comply with all related Sections of Division 23.

Control of HVAC Equipment

9. A fire condition initiation of shutdown via the existing central fire alarm system (CFAS) panel shall be implemented as specified herein and where indicated on the Contract Drawings. The fire alarm panel shall initiate a contact opening to each local HVAC equipment's controller (motor starter, VFD, etc) to signal a fire condition and stop the fan(s) and close all the appropriate dampers and louvers. The interface between the individual HVAC equipment's controllers and the fire alarm panel shall be through addressable relays and monitoring modules.

10. The control system shall notify the operator by alarm if a unit is not ready, not in either automatic mode or running. The operator shall have the option to disable this feature on a unit by unit basis.

11. Appropriate and adjustable time delays shall be provided during a system recovery from shutdown, power failure, etc., to prevent all ventilation units from restarting at the same time.

12. All equipment shall recover from power failure by coming back ready to operate.

1.06 QUALITY ASSURANCE

Not used.

1.07 SUBMITTALS

Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

   a. Detailed, written sequence of operation for each system, describing how the system will operate, the various modes of operation, alarms and individual equipment control functionality as well as all interlocked devices.

1.08 DELIVERY, STORAGE, AND HANDLING

Not used.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

Not used.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Not used.

2.02 MATERIALS / EQUIPMENT

Not used.

2.03 FABRICATION / ASSEMBLING / FINISHES

Not used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

Not used.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

Not used

3.02 APPLICATION

General HVAC System Control Strategies (Applies to All Fans)

1. All controls required to implement the control sequence strategy shall be furnished under this section of the Specifications.
2. The control system shall be housed in a NEMA 4X control panel, unless otherwise indicated. Each control panel shall be provided with:

a. Start/stop push button.

b. Hand-off-auto switches.

c. Indication lights – for ready, run status.

d. Alarm light for smoke (or fire), freeze and dirty filter.

3. Control logic for heating, ventilating, fans, etc. shall be implemented locally using DDC or PLC logic within the individual local control panel (LCP). Temperature control shall be implemented using individual local temperature controllers. Refer to Contract Drawings or equipment schedule and control diagrams for complete listing of interlocking schemes.

4. A freezestat shall be located downstream of each heating coil for HV units. Operation of the freezestat shall be as previously specified.

5. A normally closed dry contact shall be provided to each HVAC fan's (including those inside the Dehumidifcation units) starter / VFD controller to initiate shut down of the HVAC equipment in a smoke/fire condition from the central fire alarm system (CFAS). Duct mounted smoke detectors shall be furnished and wired by the Electrical Contractor where indicated on the Contract Drawings. Upon detection of smoke from the duct detector, an alarm to the CFAS shall be activated, and the respective HVAC fans shall shut down after receipt of signal from the CFAS. Shutdown shall occur in any mode of operation of the HVAC systems, i.e. manual, automatic, etc. All fan systems must be manually reset at the CFAS after a smoke condition before restarting.

6. Motor operated smoke dampers shall be provided where indicated on the Contract Drawings. Operation of the smoke dampers shall be as previously specified.

7. Normally closed dry contacts shall be provided to the system panel for shut down of equipment in an emergency condition. Upon activation of a Emergency Stop (E-Stop) switch, an alarm to the LCP shall be activated, and the HVAC control panel shall initiate the shut-down of the necessary HVAC equipment.

8. Differential pressure switches shall be installed in the filter banks of the units to sense pressure drop through the filters on the supply and return air side for HV, HRU, fans, etc. Operation of the differential pressure switch shall be as previously specified.

9. All control devices shall be suitable for corrosive atmosphere.

10. Interconnecting wiring and conduits between the field mounted devices such as discharge controllers, motor operated dampers, and between local and remote panels, etc. shall be furnished and installed under Specification

23 09 00 – Instrumentation and Controls Scope and General Requirements for HVAC and this section of the Specifications.

TITLE: SCREEN CHAMBER VENTILATION CONTROL

DRAWING(S): KSCR-H-302, KSCR-H-401, KSCR-H-805

EQUIPMENT: EF1-1, EF1-2 (standby), EF2-1, EF2-2, EF2-3, EF2-4 (standby)
MOD-PV-1, PV-2, MOD SV-1, SV-2, SV-3, SV-4

CONTROL PANEL: SC-HLCP-01

DESCRIPTION:

11. Primary Ventilation Automatic Operation (via Manual-Auto Selector Switch)
    a. With the MANUAL/AUTO selector in the AUTO position, EF1-1, EF1-2, EF2-1, EF2-2, EF2-3, and EF2-4 shall be interlocked.
    b. When the panel mounted selector switches for EF1-1, EF1-2, EF2-1, EF2-2, EF2-3, and EF2-4 are in the AUTO position, EF1-1 exhaust air motorized damper and primary ventilation intake air motorized dampers MOD-PV-1 and MOD-PV-2 shall be indexed to open.
    c. When EF1-1, MOD-PV-1, and MOD-PV-2 motorized dampers have fully opened, as proven by their damper motor end switches, EF1-1 exhaust fan shall start and run continuously.
    d. Logic within the HVAC Local Control Panel SC-HLCP-01 shall be provided to operate the exhaust fans EF1-1 and EF1-2, including a Lead/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.
    e. CO Gas Detection: When a high level alarm input signal is received from the carbon monoxide gas detection system controller during Manual or Automatic mode, exhaust fans EF1-1 or EF1-2 shall be immediately stopped and their exhaust air dampers automatically closed. The logic within the HVAC Local Control Panel SC-HLCP-01 shall provide ventilation switchover Secondary Ventilation mode.
12. Secondary Ventilation Automatic Operation (via Manual-Auto Selector Switch)
    a. With the MANUAL/AUTO selector in the AUTO position, EF1-1, EF1-2, EF2-1, EF2-2, EF2-3, and EF2-4 shall be interlocked.
    b. When the HVAC Local Control Panel SC-HLCP-01 receives a high level alarm signal from the carbon monoxide gas detection system

controller, EF2-1, EF2-2, and EF2-3 motorized exhaust air dampers and intake air motorized dampers MOD-SV-1, SV-2, SCV-3 and SV-4 shall be to open.

c. When EF2-1, EF2-2, and EF2-3 motorized exhaust air dampers have fully opened, as proven by their motor end switches, EF2-1, EF2-2, and EF2-3 shall start and run continuously until the high level carbon monoxide signal is cleared at the carbon monoxide gas detection system controller. Logic within the HVAC local control panel SC-HLCP-01 shall be provided to operate the exhaust fans EF2-1, EF2-2, EF2-3 and EF2-4, including a Lead/Standby configuration for EF2-4. In the event one of the three fans is inoperable during a CO detection event, the standby fan shall be started.

d. Once the high-level carbon monoxide signal is cleared at the carbon monoxide gas detection system controller, the HVAC local Control Panel SC-HLCP-01 shall resume Primary Ventilation mode as described above.

13. EF1-1 and EF1-2 Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector switch of the exhaust fan is in the MANUAL position, the exhaust fan shall be started by pushing the START button.

b. Upon pressing the START push button, the exhaust fan's exhaust air motorized damper and motorized intake air dampers MOD-PV-1 and MPD-PV-2 shall be indexed to open.

c. When the exhaust fan's motorized exhaust air damper and intake air MOD-PV-1, and MOD-PV-2 motorized dampers have fully opened, as proven by their damper motor end switches, the exhaust fan shall start.

d. Selecting the STOP push button will cause the exhaust fan to stop immediately and close the exhaust and intake air dampers.

e. If during MANUAL operation the HVAC Local Control Panel SC-HLCP-01 receives a high level alarm signal from the carbon monoxide gas detection system controller, the HLCP shall resort to Secondary Ventilation Automatic Operation mode.

14. EF2-1, EF2-2, EF2-3, and EF2-4 Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector switch of the exhaust fan is in the MANUAL position, the exhaust fan shall be started by pushing the START button.

b. Upon pressing the START push button, the exhaust fan's exhaust air motorized damper and motorized intake air dampers MOD-SV-1, SV-2, SV-3 and SV-4 shall be indexed to open.

c. When the exhaust fan's motorized exhaust air damper and intake air MOD-SV-1, SV-2, SV-3 and SV-4 motorized dampers have fully opened, as proven by their damper motor end switches, the exhaust fan shall start.

d. Selecting the STOP push button will cause the exhaust fan to stop immediately and close the exhaust and intake air dampers.

e. If during MANUAL operation the HVAC Local Control Panel SC-HLCP-01 receives a high level alarm signal from the carbon monoxide gas detection system controller, the HLCP shall resort to Secondary Ventilation Automatic Operation mode.

15. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

b. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

c. An airflow switch shall be provided in the exhaust ductwork near the inlet of each exhaust fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

16. SCADA System Alarms: The following common alarms shall be sent to the plant's SCADA system. Each common listed alarm below shall be provided through a set of dry contacts in the local control panel for SCADA system interface.

a. TBD

17. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

18. Duct mounted smoke duct detectors shall be located Upstream of the exhaust fans as indicated on the Contract Drawings and shall be furnished and wired under this Contract. Operation of duct mounted smoke detectors and remote CFAS shutdown signals shall be as previously specified.

TITLE: INJECTOR ROOM VENTILATION CONTROL

DRAWING: KSCR-H-304, KSCR-H-402, KSCR-H-803

EQUIPMENT: EF-3, DHU-2

CONTROL PANEL: WA-HLCP-03

19. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position, EF-3 and DHU-1 shall be interlocked.

    b. With the MANUAL/AUTO selector in the AUTO position, DHU-2 shall run under its own local control sequence. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units. The Dehumidification unit shall provide a run signal to the HVAC Local Control Panel WA-HLCP-03 for EF-3 start interlock.

    c. When the panel mounted selector switch for EF-3 is in the AUTO position, and the HVAC local control panel WA-HLCP-03 receives a run signal from DHU-2, EF-3 exhaust air motorized damper shall be indexed to open.

    d. When EF-3 motorized damper has fully opened, as proven by its damper motor end switch, EF-3 exhaust fan shall start and run continuously.

    e. When the HVAC local control panel WA-HLCP-03 receives an off signal from DHU-2, EF-3 shall shut down and its exhaust dampers shall close.

    f. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel, the local control panel shall immediately shut down DHU-2 and EF-3 and close EF-3 exhaust air dampers.

20. DHU-2 Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for DHU-2 in the MANUAL position, the dehumidification unit shall be started by pushing the START button.

    b. Upon pushing the START button, the dehumidification unit DHU-2 shall operate under its own local control. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units.

    c. With the MANUAL/AUTO selector for DHU-2 in the MANUAL position. Upon pushing the STOP push button, the dehumidification unit DHU-2 shall immediately stop.

    d. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for DHU-2 is in the MANUAL position and the unit is running, the dehumidification unit shall immediately stop.

21. EF-3 Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for EF-3 in the MANUAL position and upon pressing the START push button, the exhaust fan shall start and run independent of the dehumidification unit DHU-2. Upon pushing the START button, the exhaust damper shall open. When the exhaust damper has fully opened, as proven by the damper motor's end switch, the exhaust fan will start. Pushing the OFF pushbutton will cause the fan to stop immediately and close the exhaust dampers.

    b. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for the exhaust fan is in the MANUAL position and the fan is running, the fan shall immediately stop and its exhaust dampers shall close.

22. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

    b. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

    c. An airflow switch shall be provided in the exhaust ductwork near the inlet of each exhaust fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

23. SCADA System Alarms: The following common alarms shall be sent to the plant's SCADA system. Each common listed alarm below shall be provided through a set of dry contacts in the local control panel for SCADA system interface.

    a. TBD

24. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: RAW WATER STRAINER, WATER QUALITY MONITORING, AND FLUORIDE ROOM VENTILATION CONTROL

DRAWING: KSCR-H-304, KSCR-H-402, KSCR-H-403, KSCR-H-804

EQUIPMENT: DHU-1, EF-4

CONTROL PANEL: WA-HLCP-04

DESCRIPTION

25. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position, EF-4 and DHU-1 shall be interlocked.

    b. With the MANUAL/AUTO selector in the AUTO position, DHU-1 shall run under its own local control sequence. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units. The Dehumidification unit shall provide a run signal to the HVAC Local Control Panel WA-HLCP-03 for EF-4 start interlock.

    c. When the panel mounted selector switch for EF-4 is in the AUTO position, and the HVAC local control panel WA-HLCP-03 receives a run signal from DHU-1, EF-4 exhaust air motorized damper shall be indexed to open.

    d. When EF-4 motorized damper has fully opened, as proven by its damper motor end switch, EF-4 exhaust fan shall start and run continuously.

    e. When the HVAC local control panel WA-HLCP-03 receives an off signal from DHU-1, EF-4 shall shut down and its exhaust dampers shall close.

    f. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel, the local control panel shall immediately shut down DHU-1 and EF-4 and close EF-4 exhaust air dampers.

26. DHU-2 Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for DHU-1 in the MANUAL position, the dehumidification unit shall be started by pushing the START button.

    b. Upon pushing the START button, the dehumidification unit DHU-2 shall operate under its own local control. Refer to Specification Section 23 84 19 – Desiccant Dehumidification Units.

    c. With the MANUAL/AUTO selector for DHU-1 in the MANUAL position. Upon pushing the STOP push button, the dehumidification unit DHU-1 shall immediately stop.

    d. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for DHU-1 is in the MANUAL position and the unit is running, the dehumidification unit shall immediately stop.

27. EF-3 Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EF-4 in the MANUAL position and upon pressing the START push button, the exhaust fan shall start and run independent of the dehumidification unit DHU-2. Upon pushing the START button, the exhaust damper shall open. When the exhaust damper has fully opened, as proven by the damper motor's end switch, the exhaust fan will start. Pushing the OFF pushbutton will cause the fan to stop immediately and close the exhaust dampers.

b. When the HVAC local control panel WA-HLCP-03 receives a shutdown signal from the scrubber system control panel and the MANUAL/AUTO selector for the exhaust fan is in the MANUAL position and the fan is running, the fan shall immediately stop and its exhaust dampers shall close.

28. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

b. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

c. An airflow switch shall be provided in the exhaust ductwork near the inlet of each exhaust fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

29. SCADA System Alarms: The following common alarms shall be sent to the plant's SCADA system. Each common listed alarm below shall be provided through a set of dry contacts in the local control panel for SCADA system interface.

1) TBD

30. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: ELECTRIC ROOM THERMOSTATICALLY CONTROLLED FANS

DRAWING: KSCR-H-303, KSCR-H-402, KSCR-H-403, KSCR-H-801

EQUIPMENT: EF-6, EF-7 (standby), GIH-1

CONTROL PANEL: WA-HLCP-01

DESCRIPTION:

31. Hand Operation: With the remote mounted Hand-Off-Auto switch of the respective fan in the "Hand" position the system shall open all associated

dampers. When the dampers have fully opened, as proven by the damper motor end switch, the fan shall start.

32. Off: When the Hand-Off Auto switch is placed in the "Off" position, the fan shall stop immediately and all dampers shall close.

33. Auto Operation: With the Hand-Off-Auto switch in the "Auto" position, the respective fans shall be started and stopped by the room thermostat. Set point of the fans' thermostat shall be 95 degrees F (unless indicated otherwise on the Contract Drawings). Set points shall be field adjustable. Operation of the fans' start and stop sequence shall be the same as for hand operation.

34. Logic within the HVAC Local Control Panel WA-HLCP-01 shall be provided to operate the exhaust fans EF-6 and EF-7, including a Lead/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

35. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

36. Remote Controls: The Contractor shall furnish, install and connect a remote room thermostat as indicated.

37. Smoke Shutdown: Fans shall shut down in any mode upon signal from the CFAS as previously specified.

TITLE: ELECTRIC UNIT HEATERS CONTROL

DRAWING(S): KSCR-H-402

EQUIPMENT: EUH-1

DESCRIPTION:

38. Each electric unit heater shall be provided with a two stage room thermostat with a "Hand-Off-Automatic" switch. With the switch in the "Automatic" position, the room thermostat shall stop or start the fan to maintain room conditions at the set point. In the "Hand" position, the fan shall operate continuously.

39. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

40. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

TITLE: POLICE BOOTH VENTILATION SYSTEM CONTROL

DRAWING(S): KSPB-H-401, KSPB-H-902, KSPB-H-903

EQUIPMENT: EAF-1, EDH-1, ERV-1, MD-1, MD-2, FSD-1, FSD-2

CONTROL PANEL: PB-HLCP-01

DESCRIPTION:

41. Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for ERV-1 in MANUAL position upon pressing the START push button, the motorized dampers MD-1 and MD-2 shall open. When the damper has fully opened, as proven by the damper motor's end switch, ERV-1 fans shall start. Pushing the OFF pushbutton will cause ERV-1 fans to stop immediately and close the motorized dampers.

    b. Upon visual confirmation of exterior doors in the Police Booth being open post which with the MANUAL/AUTO selector for EAF-1 in MANUAL position upon pressing the START push button, the motorized dampers MD-1 and MD-2 shall open, combination fire and smoke dampers FSD-1 and FSD-2 shall open. When the motorized damper and combination fire and smoke damper has fully opened, as proven by the damper motor's end switch, EAF-1 fan shall start. Pushing the OFF pushbutton will cause EAF-1 fans to stop immediately and close the motorized dampers.

42. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position. Logic within the HVAC Local Control Panel PB-HLCP-01 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

    b. When PB-HLCP-01 receives a run signal from ERV-1, MD-1 and MD-2 motorized dampers shall be indexed to open. FSD-1 and FSD-2 combination fire-smoke dampers shall be indexed to closed.

    c. When MD-1 and MD-2 have fully opened and FSD-1 and FSD-2 have fully closed, as proven by the damper motor end switches, ERV-1 shall run under its control sequence.

    d. With the MANUAL/AUTO selector for EDH-1 electric duct heater in the AUTO position, and when ERV-1 supply fan is running, as proved by its air flow switch, the duct thermostat shall modulate the electric duct heater controller to meet supply air setpoint. Set point of the duct heater's thermostat shall be 68 degrees F (unless indicated otherwise on the Contract Drawings). Set points shall be field adjustable.

e. When the HVAC local control panel PB-HLCP-01 receives an off signal from ERV-1, MD-1 and MD-2 shall close. FSD-1 and FSD-2 shall remain closed. EDH-1 shall de-energize.

43. Clean Agent HVAC System Shutdown:

a. Fans EAF-1, ERV-1, duct heater EDH-1 and Variable Refrigerant Flow (VRF) shall shut down in any mode upon signal from the clean agent system control panel.

b. All combination fire smoke dampers and motorized dampers shall close in any mode upon signal from the clean agent system control panel.

44. Post-Event Clean Agent Purge:

a. Upon visual confirmation of exterior doors in the Police Booth being open purge mode shall be activated by purge switch at clean agent system control panel to allow the rooms to be purged entirely of clean agent after a discharge has occurred.

b. When purge mode activated by purge switch, FSD-1 and FSD-2 combination fire smoke dampers and MD-1 and MD-2 motorized dampers shall be opened by signal from clean agent system control panel. Upon confirmation from end switches that dampers are open, EAF-1 exhaust fan shall energize in purge mode until purge switch is manually deactivated.

45. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. Logic within the HVAC Local Control Panel PB-HLCP-01 shall be provided to prevent EAF-1 and ERV-1 running simultaneously.

b. Clean agent system control panel shall have shutdown control of the HVAC equipment in all modes.

c. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the Local Control Panel when airflow is not detected.

46. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: POLICE BOOTH HEATING AND AIR CONDITIONING SYSTEM CONTROL

DRAWING(S): KSPB-H-401, KSPB-H-902, KSPB-H-903

EQUIPMENT: ACU-1, ACU-2, ACU-3, ACU-4, ACCU-1, EUH-1, BBH-1 (x3), BBH-2 (x3), BBH-3 (x2), BBH-4 (x1)

CONTROL PANEL: PB-HLCP-01

DESCRIPTION:

47. Air Conditioning Units

    a. The indoor air conditioning units ACU-1, ACU-2, ACU-3 and ACU-4 shall be controlled via room thermostat and controller furnished by the unit manufacturer.

48. Electric Unit Heaters

    a. Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room set point. The internal thermostat shall deenergize the electric heating coil when the fan is off and energize the electric heating coil when the fan is on.

    b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

    c. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

49. Electric Baseboard Heaters

    a. Each electric baseboard heater shall be provided with a built-in adjustable thermostat. The built-in thermostat shall activate or deactivate electric heating element to maintain room conditions at the set point.

    b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition.

    c. All controls, instruments, panels, and all electrical equipment associated with baseboard heaters shall be approved for the service and classification where installed.

50. Normal Operation:

a. Air conditioning unit controller shall vary refrigerant flow as needed to maintain space temperature cooling setpoint. The ACU fans to operate continuously.

1) Security Room cooling setpoint shall be 75 degrees F (adjustable).

2) Control Room cooling setpoint shall be 75 degrees F (adjustable).

3) Electrical Room cooling setpoint shall be 85 degrees F (adjustable).

b. Electric unit heater shall activate or deactivate heating element and fans as needed to maintain space temperature heating setpoint.

1) Electrical Room heating setpoint shall be 60 degrees F (adjustable).

c. Electric baseboard heaters shall activate or deactivate heating element as needed to maintain space temperature heating setpoint.

1) Security Room heating setpoint shall be 68 degrees F (adjustable).

2) Control Room heating setpoint shall be 68 degrees F (adjustable).

51. Clean Agent System Shutdown:

a. Indoor units ACU-1, ACU-2, ACU-3 and ACU-4 shall shut down in any mode upon signal from the clean agent system control panel.

b. Outdoor unit ACCU-1 shall shut down in any mode upon signal from the clean agent system control panel.

52. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

a. Leak detection for ceiling cassette indoor air conditioning units shall be provided by the Contractor. If water sensor detects presence of water, a visual alarm shall be generated at the local control panel PB-HLCP-01 and the ceiling cassette indoor unit shall shutdown.

b. If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, the indoor air conditioning unit's controller shall generate a visual alarm at the local control panel PB-HLCP-01.

c. In Electrical Room, if space temperature drops 2 degrees F (adjustable) below heating setpoint for a 10-minute (adjustable) time period, a space temperature sensor shall generate a visual alarm at the local control panel PB-HLCP-01.

d. The local control panel PB-HLCP-01 shall monitor dry contact provided by the indoor air conditioning unit manufacturer. A visual alarm shall be generated at PB-HLCP-01 upon system alarm/trouble.

e. The local control panel PB-HLCP-01 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at PB-HLCP-01 in the event of an over temperature condition.

f. The local control panel PB-HLCP-01 shall monitor a dry contact from each electric baseboard heater, provided by manufacturer. A visual alarm shall be generated at PB-HLCP-01 in the event of an over temperature condition.

g. Clean agent system control panel shall have shutdown control of the equipment in all modes.

TITLE: ELECTRICAL BUILDING UNIT SUBSTATION ROOM AND MV SWITCHGEAR ROOM HVAC SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-904, KSEB-H-905, KSEB-H-906

EQUIPMENT: RTU-1, RTU-2, EAF-1, EAF-2 (standby), EAF-3, EAF-4 (standby), SAF-1, SAF-2 (standby), SAF-3, SAF-4 (standby), MD-01, MD-02, MD-03, MD-04A, MD-04B, MD-05, MD-06A, MD-06B, MD-07, MD-08A, MD-08B, MD-09, MD-10A, MD-10B, FSD-01, EUH-3 (x6)

CONTROL PANELS: EB-HLCP-01, EB-HLCP-02

DESCRIPTION:

53. Unit Substation Room HVAC System Control

a. The Unit Substation Room is served by supply and exhaust fans, in duty/standby configuration, to provide mechanical ventilation to maintain space setpoint. When it is not possible to meet space setpoints through mechanical ventilation, a rooftop air conditioning unit provides the necessary heating or cooling.

b. The supply fans and rooftop air conditioning unit share the same supply air distribution ductwork and require motorized dampers to isolate the inactive equipment. Likewise, the exhaust fans and rooftop air conditioning unit share the same return air distribution ductwork and require motorized dampers to isolate the inactive equipment.

c. The Unit Substation Room HVAC system setpoints are as follows:

1) Cooling setpoint = 95 degrees F (adjustable)

2) Heating setpoint = 60 degrees F (adjustable)

d. Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the fans and rooftop air conditioning unit as follows:

1) If outside air dry bulb temperature is greater than 80 degrees F or space temperature is less than 60 degrees F:

a) EAF-1, EAF-2, SAF-1 and SAF-2 are disabled

b) RTU-1 operates in automatic mode

2) If outside air dry bulb temperature is less than or equal to 80 degrees F and space temperature is greater than or equal to 60 degrees F:

a) EAF-1, EAF-2, SAF-1 and SAF-2 operate in automatic mode

b) RTU-1 is disabled

e. EAF-1, EAF-2, SAF-1 and SAF-2 Automatic Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector in the AUTO position, supply fans SAF-1 and SAF-2 shall be interlocked to exhaust fans EAF-1 and EAF-2.

2) When the panel mounted selector switches for EAF-1, EAF-2, SAF-1 and SAF-2 are in the AUTO position, motorized dampers MD-04A, MD-04B, MD-10A and MD-10B shall be indexed to closed. The fans shall be started and stopped by the room thermostat.

3) When the LCP receives a signal to start fans, MD-04A and MD-10A shall be indexed to open, MD-03 and MD-09 shall be indexed to closed.

4) When motorized dampers MD-04A and MD-10A have fully opened and MD-03 and MD-09 have fully closed as proven by their damper motor end switches, SAF-1 supply fan and EAF-1 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the supply fans SAF-1 and SAF-2, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

6) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the exhaust fans EAF-1 and

EAF-2, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

f. EAF-1, EAF-2, SAF-1 and SAF-2 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector switch of the fan in the MANUAL position, the fan shall be started by pushing the START button.

2) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one supply fan to operate at a time to prevent damage to the supply ductwork system.

3) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one exhaust fan to operate at a time to prevent damage to the exhaust ductwork system.

4) Upon pressing the START push button, the motorized damper corresponding to the fan shall be indexed to open, MD-03 and MD-09 shall be indexed to closed.

5) When the motorized damper corresponding to the fan is fully opened and MD-03 and MD-09 have fully closed as proven by their damper motor end switches, fan shall start.

6) Selecting the STOP push button will cause the fan to stop immediately and close the motorized damper corresponding to the fan.

g. RTU-1 Automatic Operation (via Manual-Auto Selector Switch):

1) When the panel mounted selector switch for RTU-1 is in the AUTO position, and the HVAC local control panel EB-HLCP-02 receives a run signal from RTU-1, MD-03 and MD-09 motorized dampers shall be indexed to open, MD-04A, MD-04B, MD-10A and MD-10B motorized dampers shall be indexed to closed.

2) When motorized dampers MD-03 and MD-09 have fully opened and MD-04A, MD-04B, MD-10A and MD-10B have fully closed, as proven by the damper motor end switches, RTU-1 shall run under its own local control sequence. Refer to Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

3) When the HVAC local control panel EB-HLCP-02 receives an off signal from RTU-1, RTU-1 shall shut down and MD-03 and MD-09 shall close.

h. RTU-1 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector for RTU-1 in the MANUAL position, the rooftop air conditioning unit shall be started by pushing the START button.

2) Upon pushing the START button, MD-03 and MD-09 motorized dampers shall be indexed to open, MD-04A, MD-04B, MD-10A and MD-10B motorized dampers shall be indexed to closed.

3) When motorized dampers MD-03 and MD-09 have fully opened and MD-04A, MD-04B, MD-10A and MD-10B have fully closed, as proven by the damper motor end switches, RTU-1 shall run under its own local control sequence. Refer to Specification Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

4) With the MANUAL/AUTO selector for RTU-1 in the MANUAL position. Upon pushing the STOP push button, the rooftop air conditioning unit RTU-2 shall immediately stop and MD-03 and MD-09 shall close.

i. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

1) Supply fans SAF-1 and SAF-2 shall be interlocked to exhaust fans EAF-1 and EAF-2.

2) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to prevent supply and exhaust fans running while rooftop air conditioning unit is running.

3) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to prevent both supply fans or both exhaust fans running simultaneously.

4) A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

5) An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

6) An airflow switch shall be provided in the ductwork near the inlet of each exhaust fan and near the discharge of each supply fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

7) In the event of a fault with all supply fans, all exhaust fans and rooftop air conditioning concurrently, an alarm shall be

made at the LCP and MD-01 and MD-02 shall be indexed open to allow minimal cooling from MV Switchgear Room HVAC system.

8) If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-02.

9) If space temperature drops 2 degrees F (adjustable) below heating setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-02.

10) The local control panel EB-HLCP-02 shall monitor dry contact provided by the rooftop air conditioning unit manufacturer. A visual alarm shall be generated at EB-HLCP-02 upon system alarm/trouble.

11) The local control panel EB-HLCP-02 shall monitor dry contact from each fan, provided by the fan unit manufacturer. A visual alarm shall be generated at EB-HLCP-02 upon system alarm/trouble.

12) The local control panel EB-HLCP-02 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-02 in the event of an over temperature condition.

j. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

k. Remote Controls: The Contractor shall furnish, install and connect a remote room thermostat as indicated.

54. MV Switchgear Room HVAC System Control

a. The MV Switchgear Room is served by supply and exhaust fans, in duty/standby configuration, to provide mechanical ventilation to maintain space setpoint. When it is not possible to meet space setpoints through mechanical ventilation, a rooftop air conditioning unit provides the necessary heating or cooling.

b. The supply fans and rooftop air conditioning unit share the same supply air distribution ductwork and require motorized dampers to isolate the inactive equipment. Likewise, the exhaust fans and rooftop air conditioning unit share the same return air distribution ductwork and require motorized dampers to isolate the inactive equipment.

c. The MV Switchgear Room HVAC system setpoints are as follows:

1) Cooling setpoint = 95 degrees F (adjustable)

2) Heating setpoint = 60 degrees F (adjustable)

d. Logic within the HVAC Local Control Panel EB-HLCP-01 shall be provided to operate the fans and rooftop air conditioning unit as follows:

1) If outside air dry bulb temperature is greater than 85 degrees F or space temperature is less than 60 degrees F:

a) EAF-3, EAF-4, SAF-3 and SAF-4 are disabled

b) RTU-2 operates in automatic mode

2) If outside air dry bulb temperature is less than or equal to 85 degrees F and space temperature is greater than or equal to 60 degrees F:

a) EAF-3, EAF-4, SAF-3 and SAF-4 operate in automatic mode

b) RTU-2 is disabled

e. EAF-3, EAF-4, SAF-3 and SAF-4 Automatic Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector in the AUTO position, supply fans SAF-3 and SAF-4 shall be interlocked to exhaust fans EAF-3 and EAF-4.

2) When the panel mounted selector switches for EAF-3, EAF-4, SAF-3 and SAF-4 are in the AUTO position, motorized dampers MD-06A, MD-06B, MD-08A and MD-08B shall be indexed to closed. The fans shall be started and stopped by the room thermostat.

3) When the LCP receives a signal to start fans, MD-06A and MD-08A shall be indexed to open, MD-05 and MD-07 shall be indexed to closed.

4) When motorized dampers MD-06A and MD-08A have fully opened and MD-05 and MD-07 have fully closed as proven by their damper motor end switches, SAF-3 supply fan and EAF-3 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the supply fans SAF-3 and SAF-4, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

6) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to operate the exhaust fans EAF-3 and EAF-4, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

f. EAF-3, EAF-4, SAF-3 and SAF-4 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector switch of the fan in the MANUAL position, the fan shall be started by pushing the START button.

2) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one supply fan to operate at a time to prevent damage to the supply ductwork system.

3) Logic within the HVAC Local Control Panel EB-HLCP-02 shall be provided to only allow one exhaust fan to operate at a time to prevent damage to the exhaust ductwork system.

4) Upon pressing the START push button, the motorized damper corresponding to the fan shall be indexed to open, MD-05 and MD-07 shall be indexed to closed.

5) When the motorized damper corresponding to the fan is fully opened and MD-05 and MD-07 have fully closed as proven by their damper motor end switches, fan shall start.

6) Selecting the STOP push button will cause the fan to stop immediately and close the motorized damper corresponding to the fan.

g. RTU-2 Automatic Operation (via Manual-Auto Selector Switch):

1) When the panel mounted selector switch for RTU-2 is in the AUTO position, and the HVAC local control panel EB-HLCP-01 receives a run signal from RTU-2, MD-05 and MD-07 motorized dampers shall be indexed to open, MD-06A, MD-06B, MD-08A and MD-08B motorized dampers shall be indexed to closed.

2) When motorized dampers MD-05 and MD-07 have fully opened and MD-06A, MD-06B, MD-08A and MD-08B have fully closed, as proven by the damper motor end switches, RTU-2 shall run under its own local control sequence. Refer to Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

3) When the HVAC local control panel EB-HLCP-01 receives an off signal from RTU-2, RTU-2 shall shut down and MD-05 and MD-07 shall close.

h. RTU-2 Manual Operation (via Manual-Auto Selector Switch):

1) With the MANUAL/AUTO selector for RTU-2 in the MANUAL position, the rooftop air conditioning unit shall be started by pushing the START button.

2) Upon pushing the START button, MD-05 and MD-07 motorized dampers shall be indexed to open, MD-06A, MD-06B, MD-08A and MD-08B motorized dampers shall be indexed to closed.

3) When motorized dampers MD-05 and MD-07 have fully opened and MD-06A, MD-06B, MD-08A and MD-08B have fully closed, as proven by the damper motor end switches, RTU-2 shall run under its own local control sequence. Refer to Specification Section 23 74 16 - Packaged, Rooftop Air-Conditioning Units.

4) With the MANUAL/AUTO selector for RTU-2 in the MANUAL position. Upon pushing the STOP push button, the rooftop air conditioning unit RTU-2 shall immediately stop and MD-05 and MD-07 shall close.

i. Electric Unit Heater Operation

1) Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room conditions at the set point.

2) The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

3) All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

4) Electric unit heater is intended for standby heating in event that the rooftop air conditioning units are out of service or do not meet the space heating setpoint. Each EUH-3 shall activate or deactivate heating element automatically, to maintain space temperature heating setpoint.

a) MV Switchgear Room heating setpoint shall be 60 degrees F (adjustable).

j. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

1) Supply fans SAF-3 and SAF-4 shall be interlocked to exhaust fans EAF-3 and EAF-4.

2) Logic within the HVAC Local Control Panel EB-HLCP-01 shall be provided to prevent supply and exhaust fans running while rooftop air conditioning unit is running.

3) Logic within the HVAC Local Control Panel EB-HLCP-01 shall be provided to prevent both supply fans or both exhaust fans running simultaneously.

4) A Central Fire Alarm System (where applicable) shall have shutdown control of the equipment in all modes.

5) An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

6) An airflow switch shall be provided in the ductwork near the inlet of each exhaust fan and near the discharge of each supply fan. An audible alarm and visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

7) In the event of a fault with all supply fans, all exhaust fans and rooftop air conditioning concurrently, an alarm shall be made at the LCP and MD-01 and MD-02 shall be indexed open to allow minimal cooling from Unit Substation Room HVAC system.

8) If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-01.

9) If space temperature drops 2 degrees F (adjustable) below heating setpoint for a 10-minute (adjustable) time period, a signal from the room thermostat shall generate a visual alarm at the local control panel EB-HLCP-01.

10) The local control panel EB-HLCP-01 shall monitor dry contact provided by the rooftop air conditioning unit manufacturer. A visual alarm shall be generated at EB-HLCP-01 upon system alarm/trouble.

11) The local control panel EB-HLCP-01 shall monitor dry contact from each fan, provided by the fan unit manufacturer. A visual alarm shall be generated at EB-HLCP-01 upon system alarm/trouble.

12) The local control panel EB-HLCP-01 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-01 in the event of an over temperature condition.

k. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

l. Remote Controls: The Contractor shall furnish, install and connect a remote room thermostat as indicated.

TITLE: ELECTRICAL BUILDING BATTERY ROOM HVAC SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-903, KSEB-H-907

EQUIPMENT: RTU-3, RTU-4 (standby), EAF-7, EAF-8 (standby), EUH-1 (standby), MD-15, MD-16, MD-17, MD-18, MD-19, MD-20

CONTROL PANEL: EB-HLCP-03

DESCRIPTION:

55. Rooftop Air Conditioning Units

a. The rooftop air conditioning units shall be controlled via room thermostat and controller furnished by the unit manufacturer. The units shall operate in a duty/standby configuration. In the event of a running unit fault, the designated standby unit shall automatically start.

56. Electric Unit Heaters

a. Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room conditions at the set point.

b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

c. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

57. Exhaust Fans

a. An exhaust fan shall run continuously to limit the buildup of hydrogen concentration in the Battery Room. The fans shall operate in a duty/standby configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

58. Normal Operation:

a. Rooftop air conditioning unit controller shall enable/disable fan and stage compressors as needed to maintain space temperature cooling and heating setpoints.

1) Battery Room RTU cooling setpoint shall be 80 degrees F (adjustable).

2) Battery Room RTU heating setpoint shall be 62 degrees F (adjustable).

b. Electric unit heater is intended for standby heating in event that the rooftop air conditioning units are out of service or do not meet the space heating setpoint. EUH-1 shall activate or deactivate heating element automatically, to maintain space temperature heating setpoint.

1) Electrical Room heating setpoint shall be 60 degrees F (adjustable).

c. Exhaust Fan Automatic Operation (via Manual-Auto Selector Switch)

1) With the MANUAL/AUTO selector in the AUTO position, exhaust fans EAF-7 and EAF-8 shall be interlocked to motorized dampers MD-19 and MD-20.

2) When the panel mounted selector switches for EAF-7 and EAF-8 are in the AUTO position, motorized dampers MD-19 and MD-20 shall be indexed to closed.

3) When the LCP receives a signal to start fans, MD-19 and MD-20 shall be indexed to open.

4) When motorized dampers MD-19 and MD-20 have fully opened as proven by their damper motor end switches, EAF-7 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-03 shall be provided to operate the exhaust fans EAF-7 and

EAF-8, including a Duty/Standby fan configuration. In the event of a running fan fault, the designated standby fan shall automatically start.

6) Logic within the HVAC Local Control Panel EB-HLCP-03 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

7) When the HVAC local control panel EB-HLCP-03 receives an off signal from EAF-7 or EAF-8, the respective fan shall shut down and MD-19 and MD-20 shall close.

59. Exhaust Fan Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EAF-7 or EAF-8 in the MANUAL position and upon pressing the START push button, motorized dampers MD-19 and MD-20 shall index to open.

b. The fan shall start upon confirmation from the other fan's airflow switch that the other fan is off and when motorized dampers MD-19 and MD-20 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-19 and MD-20 to close.

60. Alarms

a. If space temperature rises 2 degrees F (adjustable) above cooling setpoint for a 10-minute (adjustable) time period, the rooftop air conditioning unit's controller shall generate a visual alarm at the local control panel EB-HLCP-03.

b. If space temperature drops 2 degrees F (adjustable) below EUH-1 heating setpoint for a 10-minute (adjustable) time period, the electric unit heater shall generate a visual alarm at the local control panel EB-HLCP-03.

c. The local control panel EB-HLCP-03 shall monitor dry contact provided by the rooftop air conditioning unit manufacturer. A visual alarm shall be generated at EB-HLCP-03 upon system alarm/trouble.

d. The local control panel EB-HLCP-03 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-03 in the event of an over temperature condition.

e. EAF-7 exhaust fan shall be interlocked with EAF-8 in a duty/standby configuration.

f. Exhaust fans EAF-7 and EAF-8 shall be interlocked with motorized dampers MD-19 and MD-20.

g. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

61. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

62. Fan Rotational Program: the Contractor shall program a fan rotational program based on hours of operation to balance wear and tear between duty and standby fans.

TITLE: ELECTRICAL BUILDING SECURITY ROOM VENTILATION SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-902, KSEB-H-908

EQUIPMENT: EAF-5, MD-11, MD-12, SD-01, SD-02

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

63. Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EAF-5 in the MANUAL position and upon pressing the START push button, motorized dampers MD-11 and MD-12 shall index to open.

b. The fan shall start upon confirmation when motorized dampers MD-11 and MD-12 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-11 and MD-12 to close.

64. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector in the AUTO position, EAF-5 shall be interlocked with MD-11 and MD-12.

b. Logic within the HVAC Local Control Panel EB-HLCP-04 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

c. When the HVAC local control panel EB-HLCP-04 receives an off signal from EAF-5, the fan shall shut down.

65. Clean Agent System Shutdown:

a. Fan shall shut down in any mode upon signal from the clean agent system control panel.

b. All smoke dampers, SD-01 and SD-02, shall close in any mode upon signal from the clean agent system control panel.

66. Post-Event Clean Agent Release Purge:

    a. Purge mode shall be activated by purge switch at clean agent system control panel to allow the room to be purged entirely of clean agent after a discharge has occurred.

    b. When purge mode activated by purge switch, SD-01, SD-02, MD-11 and MD-12 shall be opened by signal from clean agent system control panel. Upon confirmation from end switches that dampers are open, EAF-5 exhaust fan shall operate in purge mode until purge switch deactivated.

67. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. EAF-5 exhaust fan shall be interlocked with MD-11 and MD-12.

    b. Clean agent system control panel shall have shutdown control of the equipment in all modes.

    c. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

    d. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

68. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: ELECTRICAL BUILDING COMMUNICATIONS ROOM VENTILATION SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-902, KSEB-H-908

EQUIPMENT: EAF-6, MD-13, MD-14, SD-03 and SD-04

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

69. Manual Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector for EAF-6 in the MANUAL position and upon pressing the START push button, motorized dampers MD-13 and MD-14 shall index to open.

    b. The fan shall start upon confirmation when motorized dampers MD-13 and MD-14 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-13 and MD-14 to close.

70. Ventilation Automatic Operation (via Manual-Auto Selector Switch)

    a. With the MANUAL/AUTO selector in the AUTO position, EAF-6 shall be interlocked with MD-13 and MD-14.

    b. Logic within the HVAC Local Control Panel EB-HLCP-04 shall be provided to operate the fans in automatic operation based on a field adjustable building occupancy schedule.

    c. When the HVAC local control panel EB-HLCP-04 receives an off signal from EAF-6, the fan shall shut down.

71. Clean Agent System Shutdown:

    a. Fan shall shut down in any mode upon signal from the clean agent system control panel.

    b. All smoke dampers, SD-03 and SD-04, shall close in any mode upon signal from the clean agent system control panel.

72. Post-Event Clean Agent Release Purge:

    a. Purge mode shall be activated by purge switch at clean agent system control panel to allow the room to be purged entirely of clean agent after a discharge has occurred.

    b. When purge mode activated by purge switch, SD-03, SD-04, MD-13 and MD-14 shall be opened by signal from clean agent system control panel. Upon confirmation from end switches that dampers are open, EAF-6 exhaust fan shall operate in purge mode until purge switch deactivated.

73. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. EAF-6 exhaust fan shall be interlocked with MD-13 and MD-14.

    b. Clean agent system control panel shall have shutdown control of the equipment in all modes.

    c. An emergency stop shall be provided that will stop the unit immediately and alarm to the LCP. (All)

    d. An airflow switch shall be provided in the ductwork near the discharge of each fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

74. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

TITLE: ELECTRICAL BUILDING HEAT PUMP SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-902, KSEB-H-908

EQUIPMENT: ACU-1, ACU-2, ACCU-1, ACCU-2

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

75. Each indoor heat pump unit shall be controlled via room thermostat and controller furnished by the unit manufacturer.

76. Normal Operation:

    a. Heat pump unit controller shall enable/disable fan and stage compressors as needed to maintain space temperature cooling and heating setpoints.

        1) Security Room setpoints (adjustable):

            a) Cooling setpoint shall be 80 degrees F

            b) Heating setpoint shall be 60 degrees F

        2) Communications Room setpoints (adjustable):

            a) Cooling setpoint shall be 80 degrees F

            b) Heating setpoint shall be 60 degrees F

77. Clean Agent System Shutdown:

    a. Indoor units ACU-1 and ACU-2 shall shut down in any mode upon signal from the clean agent system control panel.

    b. Outdoor units ACCU-1 and ACCU-2 shall shut down in any mode upon signal from the clean agent system control panel.

78. The following alarms, safeties and interlocks shall function in all modes. Functions apply as indicated.

    a. Leak detection for ceiling cassette indoor heat pump units shall be provided by the Contractor. If water sensor detects presence of water, a visual alarm shall be generated at the local control panel PB-HLCP-04 and the ceiling cassette indoor unit shall shutdown.

    b. Clean agent system control panel shall have shutdown control of the equipment in all modes.

TITLE: ELECTRICAL BUILDING FIRE SUPPRESSION ROOM HEATING AND VENTILATION SYSTEM CONTROL

DRAWING(S): KSEB-H-401, KSEB-H-402, KSEB-H-903, KSEB-H-908

EQUIPMENT: EAF-9, MD-21, MD-22, EUH-2

CONTROL PANEL: EB-HLCP-04

DESCRIPTION:

79. Electric Unit Heater

    a. Each electric unit heater shall be provided with an internal adjustable thermostat. The internal thermostat shall stop or start the fan to maintain room conditions at the set point.

    b. The unit shall contain all control equipment and protective equipment within the enclosure. The heater circuits shall have all fuses, contactors, etc. required to control the heat output. The unit shall have a thermal protection switch to disable the heaters in the event of an over temperature condition. The Heaters shall only operate when the fan is running.

    c. All controls, instruments, panels, and all electrical equipment associated with unit heaters shall be approved for the service and classification where installed.

80. Exhaust Fans

    a. An exhaust fan shall run continuously to purge the Fire Suppression Room of clean agent in the event of a leak from the clean agent tanks in the room.

81. Normal Operation:

    a. Electric unit heater EUH-2 shall activate or deactivate heating element automatically, to maintain space temperature heating setpoint.

        1) Fire Suppression Room heating setpoint shall be 60 degrees F

    b. Exhaust Fan Automatic Operation (via Manual-Auto Selector Switch)

        1) With the MANUAL/AUTO selector in the AUTO position, exhaust fan EAF-9 shall be interlocked to motorized dampers MD-21 and MD-22.

        2) When the panel mounted selector switch for EAF-9 is in the AUTO position, motorized dampers MD-21 and MD-22 shall be indexed to closed.

        3) When the LCP receives a signal to start fans, MD-21 and MD-22 shall be indexed to open.

        4) When motorized dampers MD-21 and MD-22 have fully opened as proven by their damper motor end switches, EAF-9 exhaust fan shall start and run continuously.

5) Logic within the HVAC Local Control Panel EB-HLCP-04 shall be provided to operate the fan in automatic operation based on a field adjustable building occupancy schedule.

6) When the HVAC local control panel EB-HLCP-04 receives an off signal from EAF-9, the fan shall shut down and MD-21 and MD-22 shall close.

82. Exhaust Fan Manual Operation (via Manual-Auto Selector Switch)

a. With the MANUAL/AUTO selector for EAF-9 in the MANUAL position and upon pressing the START push button, motorized dampers MD-21 and MD-22 shall index to open.

b. The fan shall start upon confirmation when motorized dampers MD-21 and MD-22 have fully opened as proven by their damper motor end switches. Pushing the OFF pushbutton will cause the fan to stop immediately and motorized dampers MD-21 and MD-22 to close.

83. Alarms

a. The local control panel EB-HLCP-03 shall monitor a dry contact from each electric unit heater, provided by manufacturer. A visual alarm shall be generated at EB-HLCP-03 in the event of an over temperature condition.

b. Exhaust fan EAF-9 shall be interlocked with motorized dampers MD-21 and MD-22.

c. An airflow switch shall be provided in the ductwork near the intake of the fan. A visual indication alarm (via the OIT) indicating which equipment lost airflow shall be made at the LCP when airflow is not detected.

84. Panel Controls and Indicators: The Contractor shall furnish and install the panel mounted controls and indicators as indicated on the Contract Drawings.

3.03 FIELD TESTING / QUALITY CONTROL

Not used.

3.04 STARTUP / DEMONSTRATION

Not used.

3.05 ADJUSTING / PROTECTION / CLEANUP

Not used.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 22 05 17 – Sleeves and Sleeve Seals for HVAC Piping

B. Section 22 05 18 – Escutcheons for HVAC Piping

C. Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 19 – HVAC Piping Insulation

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.

2. Joining materials.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of the following:

a. Pipe.

b. Fittings.

c. Joining materials.

2. Delegated-Design Submittal:

a. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.

b. Locations of pipe anchors and alignment guides and expansion joints and loops.

c. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

d. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

B. Informational Submittals

1. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Suspended ceiling components.

b. Other building services.

c. Structural members.

2. Qualification Data: For Installer.
3. Welding certificates.
4. Field quality-control reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copper Tube and Fittings
1. Copper or Bronze Pressure-Seal Fittings:
a. Nibco
b. Mueller Industries, Inc.
c. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Copper Tube and Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).
2. Copper or Bronze Pressure-Seal Fittings:
a. Housing: Copper.
b. O-Rings and Pipe Stops: EPDM.
c. Tools: Manufacturer's special tools.
d. Minimum 200-psig working-pressure rating at 250 deg F.
3. Wrought-Copper Unions: ASME B16.22.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

3. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Piping Applications

1. Condensate-Drain Piping: Type M (Type C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Piping Installations

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

2. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

3. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

4. Install piping at indicated slopes.

5. Install piping free of sags and bends.

6. Install fittings for changes in direction and branch connections.

7. Install piping to allow application of insulation.

8. Select system components with pressure rating equal to or greater than system operating pressure.

9. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

10. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
11. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
12. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
13. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
14. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
15. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for identifying piping.
16. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."
17. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

C. Installation of Hangers and Support

1. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
2. Install the following pipe attachments:
    a. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
3. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
    a. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
    b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
    c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
    d. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    e. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    f. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    g. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

4. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

D. Pipe Joint Construction

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

3.03 FIELD TESTING / QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7

times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 22 05 17 – Sleeves and Sleeve Seals for Plumbing Piping

B. Section 22 05 18 – Escutcheons for Plumbing Piping

C. Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 19 – HVAC Piping Insulation

1.04 REFERENCES

A. ASHRAE 15 - Safety Standard for Refrigeration Systems

B. ASME B31 – Pressure Piping

1.05 DESCRIPTION

A. Section Includes:

1. Refrigerant pipes and fittings.

2. Refrigerant piping valves and specialties.

3. Refrigerants.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of valve, refrigerant piping, and piping specialty.

2. Include pressure drop, based on manufacturer's test data, for the following:

a. Thermostatic expansion valves.

b. Solenoid valves.

c. Hot-gas bypass valves.

d. Filter dryers.

e. Strainers.

f. Pressure-regulating valves.

3. Shop Drawings:

a. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.

b. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between

compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

4. Show interface and spatial relationships between piping and equipment.

5. Shop Drawing Scale: 1/4 inch equals 1 foot.

B. Informational Submittals

1. Welding certificates.

2. Field quality-control reports.

C. Closeout Submittals

1. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copper Tube and Fittings

1. Copper Pressure-Seal Fitting for Refrigerant Piping:

a. Conex Banninger – USA

b. Parker Hannifin, Sporlan Division

c. RLS LLC

d. Or approved equal.

B. Valves and Specialties

1. Diaphragm Packless Valves

a. Danfoss Inc.

b. Heldon Products

c. Parker Hannifin Corp.

d. Or approved equal

2. Packed-Angle Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
3. Check Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved Equal
4. Service Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
5. Solenoid Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
6. Safety Relief Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Parker Hannifin Corp.
   d. Or approved equal
7. Thermostatic Expansion Valves
   a. Danfoss Inc.
   b. Heldon Products
   c. Paul Mueller Company
   d. Or approved equal

8. Hot-Gas Bypass Valves
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
9. Straight-Type Strainers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
10. Angle-Type Strainers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
11. Moisture/Liquid Indicators
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
12. Replaceable-Core Filter Dryers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
13. Permanent Filter Dryers
    a. Danfoss Inc.
    b. Heldon Products
    c. Parker Hannifin Corp.
    d. Or approved equal
14. Mufflers

a. Danfoss Inc.
b. Heldon Products
c. Emerson Climate Technologies
d. Or approved equal

15. Receivers
a. Heldon Products
b. Or approved equal

16. Liquid Accumulators
a. Danfoss Inc.
b. Heldon Products
c. Parker Hannifin Corp.
d. Or approved equal

C. Refrigerants
1. ASHRAE 34, R-410A:
a. Arkema Inc.
b. DuPont Fluorochemicals Div.
c. Genetron Refrigerants
d. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Performance Requirements
1. Line Test Pressure for Refrigerant R-410A:
a. Suction Lines for Air-Conditioning Applications: 300 psig.
b. Suction Lines for Heat-Pump Applications: 535 psig.
c. Hot-Gas and Liquid Lines: 535 psig.

B. Copper Tube and Fittings
1. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B).
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
5. Brazing Filler Metals: AWS A5.8/A5.8M.

6. Flexible Connectors:
    a. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
    b. End Connections: Socket ends.
    c. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
    d. Working Pressure Rating: Factory test at minimum 500 psig.
    e. Maximum Operating Temperature: 250 deg F.
7. Copper Pressure-Seal Fittings for Refrigerant Piping:
    a. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
    b. Housing: Copper.
    c. O-Rings: HNBR or compatible with specific refrigerant.
    d. Tools: Manufacturer's approved special tools.
    e. Minimum Rated Pressure: 700 psig.

C. Valves and Specialties
1. Diaphragm Packless Valves:
    a. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
    b. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
    c. Operator: Rising stem and hand wheel.
    d. Seat: Nylon.
    e. End Connections: Socket, union, or flanged.
    f. Working Pressure Rating: 500 psig.
    g. Maximum Operating Temperature: 275 deg F.
2. Packed-Angle Valves
    a. Body and Bonnet: Forged brass or cast bronze.
    b. Packing: Molded stem, back seating, and replaceable under pressure.
    c. Operator: Rising stem.
    d. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
    e. Seal Cap: Forged-brass or valox hex cap.

f. End Connections: Socket, union, threaded, or flanged.

g. Working Pressure Rating: 500 psig

h. Maximum Operating Temperature: 275 deg F

3. Check Valves

a. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

b. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

c. Piston: Removable polytetrafluoroethylene seat.

d. Closing Spring: Stainless steel.

e. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

f. End Connections: Socket, union, threaded, or flanged.

g. Maximum Opening Pressure: 0.50 psig.

h. Working Pressure Rating: 500 psig.

i. Maximum Operating Temperature: 275 deg F.

4. Service Valves

a. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

b. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

c. Piston: Removable polytetrafluoroethylene seat.

d. Closing Spring: Stainless steel.

e. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

f. End Connections: Socket, union, threaded, or flanged.

g. Maximum Opening Pressure: 0.50 psig.

h. Working Pressure Rating: 500 psig.

i. Maximum Operating Temperature: 275 deg F.

5. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

a. Body and Bonnet: Plated steel.

b. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

c. Seat: Polytetrafluoroethylene.

d. End Connections: Threaded.

e. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.

f. Working Pressure Rating: 400 psig

g. Maximum Operating Temperature: 240 deg F

6. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

b. Piston, Closing Spring, and Seat Insert: Stainless steel.

c. Seat: Polytetrafluoroethylene.

d. End Connections: Threaded.

e. Working Pressure Rating: 400 psig.

f. Maximum Operating Temperature: 240 deg F.

7. Thermostatic Expansion Valves: Comply with AHRI 750.

a. Body, Bonnet, and Seal Cap: Forged brass or steel.

b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

c. Packing and Gaskets: Non-asbestos.

d. Capillary and Bulb: Copper tubing filled with refrigerant charge.

e. Suction Temperature: 40 deg F.

f. Superheat: Adjustable.

g. Reverse-flow option (for heat-pump applications).

h. End Connections: Socket, flare, or threaded union.

i. Working Pressure Rating: 700 psig

8. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

a. Body, Bonnet, and Seal Cap: Ductile iron or steel.

b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

c. Packing and Gaskets: Non-asbestos.

d. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

e. Seat: Polytetrafluoroethylene.

f. Equalizer: Internal.

g. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter and 24-V ac coil.

h. End Connections: Socket.

i. Set Pressure: adjustable.

j. Throttling Range: Maximum 5 psig.

k. Working Pressure Rating: 500 psig.

l. Maximum Operating Temperature: 240 deg F.

9. Straight-Type Strainers

a. Body: Welded steel with corrosion-resistant coating.

b. Screen: 100-mesh stainless steel.

c. End Connections: Socket or flare.

d. Working Pressure Rating: 500 psig.

e. Maximum Operating Temperature: 275 deg F

10. Angle-Type Strainers

a. Body: Forged brass or cast bronze.

b. Drain Plug: Brass hex plug.

c. Screen: 100-mesh monel.

d. End Connections: Socket or flare.

e. Working Pressure Rating: 500 psig.

f. Maximum Operating Temperature: 275 deg F

11. Moisture/Liquid Indicators

a. Body: Forged brass.

b. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.

c. Indicator: Color coded to show moisture content in parts per million (ppm).

d. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

e. End Connections: Socket or flare.

f. Working Pressure Rating: 500 psig.

g. Maximum Operating Temperature: 240 deg F

12. Replaceable-Core Filter Dryers
    a. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
    b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
    c. Desiccant Media: Activated charcoal
    d. Designed for reverse flow (for heat-pump applications).
    e. End Connections: Socket.
    f. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
    g. Maximum Pressure Loss: 2 psig.
    h. Rated Flow: based on installed equipment capacities.
    i. Working Pressure Rating: 500 psig.
    j. Maximum Operating Temperature: 240 deg F.
13. Permanent Filter Dryers: Comply with AHRI 730.
    a. Body and Cover: Painted-steel shell.
    b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
    c. Desiccant Media: Activated charcoal
    d. Designed for reverse flow (for heat-pump applications).
    e. End Connections: Socket.
    f. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
    g. Maximum Pressure Loss: 2 psig.
    h. Rated Flow: based on installed equipment capacities.
    i. Working Pressure Rating: 500 psig.
    j. Maximum Operating Temperature: 240 deg F
14. Mufflers
    a. Body: Welded steel with corrosion-resistant coating.
    b. End Connections: Socket or flare.
    c. Working Pressure Rating: 500 psig.

d. Maximum Operating Temperature: 275 deg F

15. Receivers: Comply with AHRI 495.

a. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

b. Comply with UL 207; listed and labeled by an NRTL.

c. Body: Welded steel with corrosion-resistant coating.

d. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.

e. End Connections: Socket or threaded.

f. Working Pressure Rating: 500 psig.

g. Maximum Operating Temperature: 275 deg F

16. Liquid Accumulators

a. Body: Welded steel with corrosion-resistant coating.

b. End Connections: Socket or threaded.

c. Working Pressure Rating: 500 psig.

d. Maximum Operating Temperature: 275 deg F

D. Refrigerants

1. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Piping Applications for Refrigerant R-410A

1. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

2. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
3. Safety-Relief-Valve Discharge Piping NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Valve and Specialty Applications

1. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
2. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
3. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
4. Install a full-size, three-valve bypass around filter dryers.
5. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
6. Install thermostatic expansion valves as close as possible to distributors on evaporators.
7. Install valve so diaphragm case is warmer than bulb.
8. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
9. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
10. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
11. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
12. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
    a. Solenoid valves.
    b. Thermostatic expansion valves.
    c. Hot-gas bypass valves.
    d. Compressor.
13. Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.

14. Install receivers sized to accommodate pump-down charge.

15. Install flexible connectors at compressors.

C. Piping Installation

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

2. Install refrigerant piping according to ASHRAE 15.

3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

6. Install piping adjacent to machines to allow service and maintenance.

7. Install piping free of sags and bends.

8. Install fittings for changes in direction and branch connections.

9. Select system components with pressure rating equal to or greater than system operating pressure.

10. Refer to Section 23 09 00 - Instrumentation and Controls Scope and General Requirements, Section 23 09 13 - Instrumentation and Control Devices for HVAC” and Section 23 09 93 - Sequence of Operations for HVAC" for solenoid valve controllers, control wiring, and sequence of operation.

11. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

12. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

13. Install refrigerant piping in protective conduit where installed belowground.

14. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

15. Slope refrigerant piping as follows:

a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

b. Install horizontal suction lines with a uniform slope downward to compressor.

c. Install traps and double risers to entrain oil in vertical runs.

d. Liquid lines may be installed level.

16. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

17. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

18. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

19. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

20. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

21. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

D. Pipe Joint Construction

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

5. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

6. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

7. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded

pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

8. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.

9. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

10. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Installation of Hangers and Supports

1. Comply with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment - for hangers, supports, and anchor devices.

2. Install the following pipe attachments:

a. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

b. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.

d. Spring hangers to support vertical runs.

e. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

3. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

4. Support horizontal piping within 12 inches of each fitting.

5. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

   a. Fill system with nitrogen to the required test pressure.

   b. System shall maintain test pressure at the manifold gage throughout duration of test.

   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.04 STARTUP / DEMONSTRATION

A. System Charging

1. Charge system using the following procedures:

   a. Install core in filter dryers after leak test but before evacuation.

   b. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

   c. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

   d. Charge system with a new filter-dryer core in charging line.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

E. Open shutoff valves in condenser water circuit.

F. Verify that compressor oil level is correct.

G. Open compressor suction and discharge valves.

H. Open refrigerant valves except bypass valves that are used for other purposes.

I. Check open compressor-motor alignment and verify lubrication for motors and bearings.

J. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all ductwork complete with auxiliary equipment and accessories as shown, specified and/or required for proper operation.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment

C. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

D. Section 23 07 13 – Duct Insulation

E. Section 23 09 13 – Instrumentation and Control Devices for HVAC

1.04 REFERENCES

A. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

B. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

1. HVAC Duct Construction Standards.

2. Seismic Restraint Manual - Guidelines for Mechanical Systems.

D. ASTM E437 Industrial Wire Cloth and Screens (Square Opening Series)

E. UL 555 - Fire Dampers.

F. UL 555S – Smoke Dampers, Combination Fire and Smoke Dampers

G. UL 181 - Factory Made Air Ducts and Connectors.

H. UL 214 - Tests for Flame Propagation of Fabrics and Films.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the ductwork.

2. Engage a firm which can show successful experience in the fabrication and erection for ductwork systems of scope and type similar to the required Work.

B. Installer Qualifications:

1. Contractor shall have at least 5 years' experience in the installation of the Work specified. He shall employ only tradesmen with specific skills and experience in this type of Work.

2. Contractor shall have undivided responsibility as a single firm for performance and other requirements for the installation of the Work specified herein.

C. Requirements of Regulatory Agencies: Comply with applicable provisions of regulatory agencies below and others having jurisdiction.

1. Underwriters Laboratories, Incorporated (UL)
2. National Fire Protection Association (NFPA).
3. National Electrical Code.
4. Local and State Building Codes and Ordinances:
   a. New York City Building Code.
   b. New York State Uniform Fire Prevention and Building Code.
5. Permits: Contractor shall obtain and pay for all required permits, fees and inspections.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. 1/4-inch scale duct layouts.
2. Dimensions.
3. Details of construction.
4. Details of installation, hanger details and spacing.
5. Manufacturer's literature, illustrations, specifications and Engineering data.
6. Registers, grilles and diffusers.
7. Fire Dampers (UL Listed):
   a. Closing mechanisms.
   b. Fusible link operating temperature.
   c. Installation details.
   d. Access Doors.
8. Smoke Dampers (UL Listed):
   a. Closing mechanisms.
   b. Installation details.
   c. Access Doors.
9. Combination Fire and Smoke Dampers (UL Listed):
   a. Closing mechanisms.
   b. Installation details.
   c. Access Doors.
10. Flexible connections.

11. Other technical data related to the specified material and equipment as requested by Engineer.

12. Duct sealants.

13. Air outlet schedule indicating room name and location of each outlet. Cross reference Contract designation and manufacturer's model number or name.

B. Test Reports: Submit the following test reports for approval where required.

1. UL Label, Fire Dampers, Smoke Dampers, Combination Fire and Smoke Dampers.

2. Volume Damper leakage tests from an AMCA-approved testing laboratory.

C. Contractor shall provide certification that all stainless steel accessories including screws, hangers, supports, etc. for stainless steel, are Type 316 stainless steel.

D. Certification: Manufacturer shall provide certified test data.

E. The Contractor shall submit details of construction to the Engineer for review

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair and adjust the materials and products provided under this Section, and as per the requirements of the Contract Documents. In addition, furnish the following spare parts:

1. Twelve (12) spare fusible links.

B. Tools: Provide standard and special tools and supplies necessary to service, disassemble, repair and adjust the products.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ductwork Accessories for Transverse Duct Connections shall be Ductmate 35® System as manufactured by Duct Mate Industries Inc., Charleroi, PA or approved equal.

B. Volume Dampers as manufactured by Ruskin Company, Grandview, MO or approved equal.

C. Rectangular fire dampers as manufactured by Air Balance, Inc., Wyalusing, PA or approved equal.

D. Air Volume Extractors as manufactured by Hart and Cooley, Grand Rapids, MI, Titus, Plano, TX or approved equal.

E. Registers, Grilles, and Diffusers: Supply Registers, Air Turning Devices, Exhaust and Return Registers and/or Grilles as manufactured by A-J Manufacturing Co., Inc., Kansas City, MO or approved equal.

F. Transfer Grilles as manufactured by A-J Manufacturing Co., Inc., Kansas City, MO or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General:

1. All work shall be constructed and installed properly in accordance with the recommendations given in the latest edition of the Sheet Metal & Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards and Rectangular Industrial Duct Construction Standards.

2. All ductwork shall be constructed in accordance with the Schedule of Metal Duct Construction Standards, located after the "End of Section" designation. The transverse duct connections shall be bolted, gasketed connections made with standard Ductmate 35 System.

3. All ducts shall conform accurately to the dimensions indicated on the Contract Drawings, shall be straight and smooth on the inside with neatly finished joints, and shall not be decreased at any point to avoid obstructions. No piping, conduit or structural work shall be installed in or through any ductwork. All ductwork shall be run as close as possible to structural members, walls and ceilings. Ductwork shall be as shown on the Contract Drawings, subject to such modifications as may be necessary to suit field conditions to clear any obstruction or conflicts with other equipment.

4. Where existing walls, floors or roofs must be penetrated, Contractor shall neatly cut the required openings and patch the existing work to provide a neat and finished appearance.

B. Metal Ductwork:

1. Stainless Steel (Type 316 stainless steel): All ductwork shall be constructed of Type 316 stainless steel except as specified below and shown on the Contract Drawings.

a. All accessories, air outlets, hardware, and fasteners shall be Type 316 stainless steel unless otherwise noted.

2. Galvanized Steel (G90 Coating): Only where specified on the Contract Drawings.

a. Air devices for galvanized ductwork shall be aluminum.

3. Aluminum (with 3003 ductwork H-14 alloy and temper): Only where specified on the Contract Drawings.

a. Air devices and ductwork accessories for aluminum ductwork shall be aluminum.

C. Stainless Steel Ductwork:

1. Stainless steel duct sheet thicknesses shall be two gauge heavier than the thickness specified in SMACNA standards for galvanized steel duct.

2. Flanged duct joints shall be 0.25-in Butyl gasketed and bolted together with stainless steel (Type 316) bolts, nuts, washers and lock washers. All duct joints shall be airtight.

3. All accessories including but not limited to, registers, grilles, diffusers, turning vanes, air turning devices, manual volume dampers, motor operated control dampers, fire dampers, and access doors installed in stainless steel ductwork shall be fabricated of the same stainless steel material as the associated ductwork. Supports, angles, clamps and hardware shall be Type 316 stainless steel.

4. Schedule:

a. All ductwork shall be fabricated and installed in accordance with the Schedule of Metal Duct Construction Standards, located after the "End of Section" designation.

b. Duct constructed of fiberglass duct board shall not be permitted on the job except where specifically specified.

D. Ductwork Accessories

1. Hangers and Supports:

a. All ductwork shall be securely hung and anchored to the building structure. Unless otherwise shown or specified, hangers and stiffeners for ducts shall conform to the recommendations given in the SMACNA HVAC Duct Construction standards and SMACNA seismic restraint manual. Ducts shall be supported on trapeze hangers with angles or rods. Use of strap hangers and straps is prohibited.

b. All ductwork shall be supported from trapeze type hangers. Hanger rods shall be minimum 3/8 inch for all ducts with half perimeter up to 72 inches, and ½ inch diameter for all ducts with half perimeter larger than 72 inches. A pair of rods shall be provided at each duct support point.

c. Maximum hanger spacing shall be 8 feet for ducts with half perimeter up to 72 inches and 6 feet for ducts with half perimeter larger than 72 inches.

d. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall be Type 316 stainless steel except for galvanized steel ductwork may be galvanized steel.

e. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.

f. Support shall be furnished at each fitting.

g. Seismic Requirements:

1) All piping and ductwork shall be provided with seismic restraints in accordance with the Seismic Restraint Manual, guidelines for Mechanical Systems dated 1991, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) and in accordance with the New York City Building Code and referenced Uniform Building Code requirements.

2) Piping and ductwork shall be supported to withstand seismic forces anticipated in seismic zones 2A.

h. Conform to all requirements of Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

2. Sleeves: Where ductwork passes through masonry walls, partitions or floors provide minimum 16 gauge, Type 316 stainless steel for stainless steel, and aluminum ductwork, and galvanized steel for galvanized ductwork. Caulk airtight with fire resistant sealant between sleeve and ductwork.

3. Volume Dampers:

a. Volume dampers shall comply with SMACNA Standards.

b. Material: As specified for ductwork.

c. Blades: Opposed blades, vinyl edge seals.

d. Provide outside handle, quadrant and approved position indicator and locking device.

e. Performance:

1) Damper Leakage: Not more than 16 cfm per square foot at 4-inch W.G.

4. Control Dampers:

a. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

b. Frames:

1) Angle shaped.

2) 0.094-inch- thick, galvanized sheet steel.

3) Mitered and welded corners.

c. Blades:

1) Multiple blade with maximum blade width of 6 inches.

2) Parallel-blade design.

3) Galvanized-steel.

4) 0.064 inch thick single skin.

d. Blade Edging: Closed-cell neoprene.

e. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1) Operating Temperature Range: From minus 40 to plus 240 deg F.

f. Bearings:

1) Molded synthetic.

2) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

3) Thrust bearings at each end of every blade.

g. Actuator: comply with requirements as required by Section 23 09 13 – Instrumentation and Control Devices for HVAC.

5. Smoke Dampers:

a. General Requirements: Label according to UL 555S by an NRTL.

b. Smoke Detector: Integral, factory wired for single-point connection.

c. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

d. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.

e. Leakage: Class III.

f. Rated pressure and velocity to exceed design airflow conditions.

g. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

h. Actuator:

1) Type: Electric 120 V, 60 Hz, two-position, fail close or Electric 24V, 60 Hz, two-position, fail close.

2) Mounting: External (out of air stream).

i. Accessories:

1) Indicator or Auxiliary Switch Package: Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2) Actuator with internal switches: Damper “open”, damper “closed”. Switches mounted internal to actuator.

3) Factory Sleeve:

a) Minimum 20 gage (1.0 mm) thickness.

b) Minimum 12 inches (305 mm) long.

4) Damper test switch - push button.

6. Combination Fire and Smoke Dampers:

a. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

b. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

c. Fire Rating: 1-1/2 hours.

d. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

e. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

f. Smoke Detector: Integral, factory wired for single-point connection.

g. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- thick, galvanized sheet steel.

h. Leakage: Class III.

i. Rated pressure and velocity to exceed design airflow conditions.

j. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

k. Master control panel for use in dynamic smoke-management systems.

l. Actuator:

1) Type: Electric 120 V, 60 Hz, two-position, fail close or Electric 24V, 60 Hz, two-position, fail close.

2) Mounting: External (out of air stream).

m. Accessories:

1) Indicator or Auxiliary Switch Package: Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2) Actuator with internal switches: Damper “open”, damper “closed”. Switches mounted internal to actuator.

3) Factory Sleeve:

a) Minimum 20 gage (1.0 mm) thickness.

b) Minimum 12 inches (305 mm) long.

4) Damper test switch - push button.

7. Self-acting Dampers

a. Self-acting dampers shall be of the adjustable, counter-balanced type and shall be fabricated blades set in frame.

b. Materials:

1) Self-acting dampers and frames installed in the stainless steel ductwork shall be of Type 316 stainless steel.

2) Self-acting dampers and frames installed in aluminum and galvanized steel ductwork shall be aluminum.

8. Fire Dampers (Dynamic Type):

a. Fire Dampers:

1) Fusible Link Fire Dampers and access doors shall be provided where indicated on the Contract Drawings and

where required by local codes. Fire dampers shall be of the curtain type with interlocking blades set in a one piece frame, and shall be suitable for installation in the vertical or horizontal position. The dampers shall conform to all requirements of the latest edition of the National Fire Code NFPA 90A and shall have a 1-1/2 or 4 hour standard fire protection rating in accordance with UL555, "Standard for Fire Dampers." Fire dampers installed in Type 316 stainless steel, aluminum, and fiberglass ductwork shall be fabricated of Type 316 stainless steel and shall be provided with vacuum formed springs. All fusible links shall be UL rated at 165°F.

b. Label:

1) All fire dampers shall have UL Label attached and galvanized steel construction for galvanized steel ductwork. Type 316 stainless steel construction for aluminum, stainless steel ductwork.

2) Label shall have a fire rating of, at a minimum:

a) 1-1/2 hours for fire separations (walls, floors and partitions) rated at 2 hours.

b) 3 hours for walls, floors and partitions rated at 3 hours and above.

3) All fire dampers shall be Dynamic Rated for closure against airflow in the following six installation configurations:

a) Vertical Mount (Horizontal Airflow): Ducted and unducted.

b) Horizontal Mount (Airflow Up): Ducted and unducted.

c) Horizontal Mount (Airflow Down): Ducted and unducted.

4) Each fire damper proposed shall be rated to close against maximum design airflow at its installed location with a 10 percent safety factor and against 8 in. w.g. maximum pressure across the closed damper.

c. Two fire dampers rated at 1-1/2 hours each, one on each face of the fire separation or fire division, are required for fire separations having a 3-hour fire rating or above as per local code.

d. Type: Galvanized steel blades for galvanized ductwork and Type 316 stainless steel blades for aluminum, stainless steel and FRP ductwork with interlocking joints and fusible links.

e. Provide firestopping at fire separations where fire dampers are installed.

f. Provide an access door in duct at each fire damper located in duct.

9. Sheet Metal Safing:

a. Provide aluminum sheet metal safing to close off and seal airtight all unused areas behind louvers.

b. Insulation shall be 2 inch thick fiberglass, permanently attached to sheet metal. Safing shall consist of a two inch thick rigid fiberglass board type insulation sandwiched between two 16 gauge minimum sheets.

c. Insulation shall be secured to the sheets with adhesive.

d. All edges of the panels shall be provided with a 16 gauge minimum channel secured in place with sheetmetal screws six inches on centers.

e. Insulated sandwich panels shall be removable type with maximum space of 18 inches, and supported on 3 x 3 x ¼" angle. Provide intermediate supports.

f. The sheets, channels and hardware used for the safing shall be 316 stainless steel.

10. Access Doors:

a. Comply with SMACNA HVAC Duct Construction Standards.

b. Type: Gasketed cam lock covers.

c. Materials: Same as duct.

d. Unless otherwise specified access doors shall be:

1) 12 by 6 inches for ducts sizes 12-inches and smaller.

2) 12 by 12-inches for ducts size 14-inches.

3) 21 by 14-inches for ducts between 14 and 36 inches.

4) 25 by 17 inches for ducts between 36 and 60 inches.

5) Two 25 by 17 inch doors for ducts larger than 61 inches.

e. Access doors for fire dampers shall be stenciled "FIRE DAMPER ACCESS" with minimum ½-inch high letters.

11. Flexible Connections:

a. Comply with SMACNA Standards for pressure classification of 3 inches water gage.

b. Material (unless otherwise specified):

1) Minimum 1/16-inch thick, 6-inch wide reinforced butyl or EPDM sheeting.

2) 16 gauge, 3-inch wide galvanized steel strip for galvanized steel ductwork. Type 316 stainless steel for stainless steel ductwork.

3) 0.080 thick 3-inch wide aluminum strip for aluminum ductwork.

12. Turning Vanes:

a. Reference: SMACNA HVAC Duct Construction Standard.

b. Material: Same material as ductwork.

c. Vanes: Double thickness.

13. Air Volume Extractors:

a. Reference: SMACNA HVAC Duct Construction Standard.

b. Material: Same material as ductwork.

c. Blades: Gang-operated curved adjustable blades controlled through manual adjusting lever.

14. Gravity Backdraft Dampers (located in ductwork):

a. Construction:

1) Multiple, interlocked blades mounted in frame.

2) Felt gasketed blade edges.

3) Stainless steel or brass bearings.

4) Tie rod connecting each blade.

5) Counterweights or adjustable spring attached to tie rods.

6) Metal frame.

b. Materials:

1) Same material as ductwork.

2) Tie Rod: Aluminum 0.081 gage.

3) Louver Arm: Aluminum 0.081 gage.

4) Bumpers: Waterproof felt.

15. Hardware:

a. All fastening devices used for aluminum, stainless steel, and ductwork shall be Type 316 stainless steel.

b. All gasketing material shall be butyl.

16. Metallic Flexible Duct:

a. Metallic type duct shall be single-ply Type 316 stainless steel.

b. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to ½ duct diameter.

c. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of minimum 5 inches water gauge at 250°F.

d. Runout length shall be limited to 10 feet and size limited to 8 inch in diameter.

17. Insulated Nonmetallic Flexible Duct Runouts:

a. Flexible duct runouts shall be used only where indicated on the Contract Drawings.

b. Runout length shall be as shown on the Contract Drawings, but shall in no case exceed 10 feet in length and 8 inch in diameter. Runouts shall be pre-insulated, factory fabricated, and shall comply with NFPA 90A and UL 181.

c. Either field or factory applied vapor barrier shall be provided.

d. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands.

e. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods.

f. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL-01.

18. High Temperature Service Duct Connections

a. Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, and plain weave fibrous glass cloth with nickel/chrome wire reinforcement for service in excess of 1200°F.

19. Air Vents and Goosenecks:

a. Air vents and goosenecks shall be fabricated from the material as specified for ductwork with structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA-06.

b. Air vents and goosenecks shall be provided with bird screen.

20. Bird Screens and Frames: (Type 316 Stainless Steel):

a. Bird screens shall conform to ASTM E437, Type I, Class 1, 2 by 2 mesh, 0.031 inch diameter stainless steel wire.

b. Frames shall be removable type stainless steel construction.

E. Registers, Grilles and Diffusers

1. General:

a. Units shall be factory-fabricated of Type 316 stainless steel construction for stainless steel ductwork; aluminum construction when installed in aluminum and galvanized steel ductwork, and shall distribute the specified of air volume (cubic feet per minute).

b. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70.

c. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers.

d. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

e. Diffusers:

1) Diffuser types shall be as indicated.

2) Diffusers shall be provided with air deflectors of the type indicated.

3) Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL-03 for the interchangeable use as cooled or heated air supply diffusers or return air units.

4) Ceiling mounted units shall be installed with rims tight against ceiling.

5) Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers.

6) Return or exhaust units shall be similar to supply diffusers.

f. Registers and Grilles:

1) Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face.

2) Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling.

3) Grilles shall be as specified for registers, without volume control damper.

g. An additional volume damper shall be installed in duct stub to each air outlet for balancing of air volume.

2. Supply registers shall be complete with adjustable vertical face bars and a key operated opposed blade damper. Supply registers installed in stainless steel ductwork shall be of Type 316 stainless steel double deflection type complete with opposed blade stainless steel damper and aluminum construction when installed in aluminum or galvanized steel ductwork.

3. Air turning devices shall be installed at all collar take-offs to supply registers.

a. The air turning devices shall have two sets of individually adjustable blades to equalize flow and control volume at collar takeoffs and shall be gasketed around the perimeter.

4. Return and exhaust registers shall be complete with fixed vertical face bars, set straight, and a key operated opposed blade damper. Return and exhaust registers and damper installed in stainless steel ductwork shall be of Type 316 stainless steel with opposed blade stainless steel damper and aluminum when installed in aluminum or galvanized steel ductwork.

5. Exhaust shall be complete with fixed vertical face bars, set straight. Return and exhaust grilles installed in stainless steel ductwork shall be of Type 316 stainless steel construction, and aluminum when installed in aluminum and galvanized steel ductwork.

6. Supply and return/exhaust diffusers shall be square plaque type, with round necks and integral volume dampers. And shall be entirely fabricated of Type 316 stainless steel construction when installed in stainless steel ductwork and aluminum construction when installed in aluminum or galvanized steel ductwork. Where required, and as indicated on the Contract Drawings, the

Contractor shall provide blank off baffles to eliminate drafts caused by nearby obstructions. Diffuser face shall be 24" x 24" except where indicated different size on plans. Diffusers installed in hung ceilings shall be provided with anti-smudge ring.

7. Supply Air Drum Louvers:

   a. Supply air drum louvers shall be with a felt seal around the rotating drum to prevent leakage. The louver shall be adjustable to direct the air stream at any angle up to 30 degree from the louver centerline either by rotating the drum or by adjusting the position of the pivoted vanes.

   b. Materials:

      1) Stainless steel construction in stainless steel ductwork.

      2) Aluminum in construction aluminum and galvanized steel ductwork.

8. Transfer Grille Assembly: Wall mounted grilles shall consist of two (2) grilles, installed flushed to each side of wall. A fire damper shall be installed between the grilles when located in fire rated walls. The fire damper shall consist of a fully adjustable, key operated opposed blade damper with a spring loaded fusible link assembly Type 316 stainless steel construction. The fusible link shall be UL rated at 160F. The entire assembly shall conform to the latest edition of the National Fire Code No. 90A. All transfer grille assembly shall be Type 316 stainless steel. Transfer grilles shall be as manufactured by:

9. Linear Bar Diffusers:

   a. Linear Bar Diffusers shall have 1/8 inch thick fixed bars at 0 degree deflection, spaced ½ inch on center, or approved equal. Linear bar diffusers shall be available in standard one-piece lengths up to 6 feet and shall have the sizes and mounting types shown on the plans. Diffuser lengths greater than 6 feet shall be furnished in multiple sections and will be joined together end-to-end with alignment strips or pins to form a continuous appearance. All alignment components shall be provided by the manufacturer.

   b. The diffuser core shall have extruded aluminum bars locked into a heavy extruded aluminum border. The deflection bars shall be fixed and parallel to the long dimension. The core shall have support bars located no more than 9 inches apart and shall be parallel to the short dimension.

   c. Heavy gauge extruded aluminum end borders and mitered corners shall be available to close off the ends of the diffusers. Opposed

blade damper shall be constructed of heavy gauge aluminum. Damper must be operable from the face of the diffuser.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Stainless Steel Ductwork

1. All stainless steel ductwork shall be shop fabricated in sections with welded flanged ends.

2. No field welding of ductwork shall be permitted.

3. Welding equipment and electrodes shall be of a type specifically suited for welding light gauge Type 316 stainless steel to provide consistently good quality welds.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.

3.02 INSTALLATION

A. Turning vanes shall be installed in all miter elbows to permit air to make the abrupt turns with a minimum of turbulence. The turning vanes shall be quiet and free from vibration when the system is in operation. Turning vanes shall be double thickness type. Vanes shall be installed in all short radius elbows in accordance with SMACNA standards and Industrial Duct Construction standards. Duct clean out doors shall be provided at each elbow with turning vanes.

B. Manual volume dampers larger than 11" in any dimension shall be opposed blade type. The damper blades shall be operated by a lockable dial regulator and may be set in any position. The dial regulators shall be marked so that the "open" and "shut" positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which will finish flush with the surface of the insulation. Manual volume dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting. Care shall be taken during installation to make certain that sheet metal fasteners do not protrude into the duct and interfere with damper operation. Dampers shall be provided in each branch duct take off and in both ducts downstream of each trunk duct split. Manual volume dampers shall be Type 316 stainless steel construction in stainless steel ductwork and aluminum construction in aluminum and galvanized steel ductwork.

C. Splitter type dampers shall not be installed.

D. Duct access doors shall be provided within working distance of, and on the fusible link side of all fire dampers, smoke dampers, combination fire and smoke dampers, adjacent to volume dampers, on the linkage side of automatic dampers and at all other apparatus requiring service or inspection in the duct system. The doors shall be rigid and airtight, and provided with neoprene gaskets, hinges and sash locks. Whenever space requirements are such that a hinged access door is impractical, a screw fastened lift-out door shall be provided instead.

E. Access doors in finished Work such as walls, plaster, wood paneling and in suspended ceilings which do not have removable panels, shall be provided for all concealed valves, controls, test openings, duct access doors, and at all other locations requiring service, inspection or adjustment of a concealed item. The Contractor shall submit details of construction and material to the Engineer for review. In general, the access doors shall match the appearance of the finished Work in which they are installed and shall be of sufficient size to permit service, inspection or adjustment of the concealed item.

F. Test openings

1. Test openings shall be sealed by a screw cap and gasket, and shall be installed so that the insulation is not disturbed when the cover is removed.

2. The test openings shall be located as follows in all heating, ventilating, air conditioning systems:

a. In the outside air duct adjacent to the unit.

b. In the exhaust air duct adjacent to the unit.

c. In the main supply duct on each unit.

G. Flexible connections for preventing the transmission of vibrations through the ductwork to the structure shall be installed between the ductwork and all air moving equipment and at the building joints. Flexible connections shall be neoprene-impregnated fabric collars with cemented seams fastened with straps and bolts of the same material as the ductwork. Flexible connections shall not be painted or used to correct misalignment. The fire damper, smoke damper or combination fire and smoke damper shall be secured to a stainless-steel collar with ¼" diameter stainless steel nuts and bolts with maximum spacing of 12 inches on center and a minimum of two fastenings per side beginning two inches from the corners of the collar. The collars shall be at least the same gauge as the ductwork to which it is attached; regardless of the duct gauge, collars shall not be lighter than 24 gauge 316 stainless steel. Retaining angles shall be installed on four sides of the collar and on both sides of the protected opening with a minimum of one inch overlap on the wall or floor. The 316 stainless steel angles shall be a minimum of 1½" x 1½" x 1/8" and shall be fastened to the collar only; do not fasten angles to the wall or floor.

H. The angles shall be fastened to the collar with ¼" diameter stainless steel nuts and bolts with a maximum spacing of 6 inches on center and a minimum of two fastenings per side beginning two inches from the corners of the collar. Where gas tight seals are required, the angles shall be fastened to the collar with a continuous weld and a sealant shall be installed between the angle and the wall or floor. Collars, angles and hardware used with stainless steel fire dampers, smoke dampers or combination fire and smoke dampers shall be Type 316 stainless steel. Clearance for expansion is required between the collar and the opening on the top and on each vertical side. The clearance shall be 1/8 inch per lineal foot of sleeve with clearance on the sides distributed equally and all vertical clearance on the top. The retaining angles shall be increased in size to provide the minimum overlap of one inch on the wall or floor. The ductwork shall be connected to the collar on each side of the wall or floor with a breakaway connection on all four sides of the collar. The distance from the wall or floor to the breakaway connection shall not exceed 6 inches.

I. Prefabricated roof curbs shall be installed before the installation of roofing.

J. Curbs to prevent water leakage shall be provided around all floor openings. Where concrete curbs are not indicated on the Contract Drawings, provide curbs fabricated of 4" x 4" x 1/4" thick angles with welded corners. The curb shall be set in a mastic compound and securely fastened to the floor to provide a watertight installation. Curbs associated with stainless steel ductwork shall be fabricated of Type 316 stainless steel.

K. Contractor shall furnish and install sleeves for registers, grilles, and dampers mounted in the masonry, concrete plenums or shafts. Sleeves shall be 16 gage Type 316 stainless steel.

L. After the installation is completed, the Contractor shall seal all joints air tight. Sealants and tape shall have a flame spread not greater than 25 and a smoke developed rating of not over 50.

M. Safing shall be provided to seal off remaining portions of shafts and louvers which are not covered by the plenums or equipment attached to the shaft or louver.

N. All bird screens shall be Type 316 stainless steel.

O. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished; ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.

P. Tape and seal all joints as per SMACNA Standards.

Q. Elbows shall have a minimum centerline radius of 1-1/2 times the width of the duct. Turning vanes shall be provided at all square elbows. Turning vanes shall be double wall and shall be quiet and free from vibration when the system is in operation.

R. Provide volume dampers where indicated on the Contract Drawings and as required to facilitate accurate volume control. The duct of the damper shall be reinforced to

prevent vibration. Volume dampers specified with air devices shall be installed in addition to those shown on the Contract Drawings.

S. Fire dampers, smoke dampers and combination fire and smoke dampers shall be provided and installed where indicated on the Drawings and where required by UL and authorities having jurisdiction, and shall be approved by local building codes and in accordance with the requirements of the NFPA.

T. Provide access doors for all dampers for inspection and maintenance.

U. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration. Flexible Connections:

1. All expansion joints in ducts at building expansion joints shall be suitably supported at each end by support guides within 12 inches of joint.

2. All ducts at flexible connections with air handling equipment, and fans shall be supported at free end within 12 inches of flexible connection.

3. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where necessary.

V. Coordinate all air outlets for compatibility with ceiling system.

W. All ductwork shall arrive on Site fully fabricated, not in two halves for field fabricated.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. ADJUSTMENT

1. Set volume control devices for approximate positions in preparation for final testing and balancing.

2. Install fusible links in fire dampers and verify that dampers are in open position.

3. Start fan system and check for excessive leaks and vibration and correct.

B. BALANCING

1. Systems shall be completely tested, adjusted and balanced by a qualified Engineer. A complete balancing procedure shall be submitted for approval. All equipment and connections required to balance the systems shall be provided.

2. All duct systems shall be balanced as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

C. CLEANING

1. Remove all loose materials and obstructions from interior of ducts.

2. Remove debris and waste materials resulting from installation.

D. PAINTING

1. Surface Preparation and Shop Painting:

   a. Clean and prime coat ferrous metal surfaces of equipment in the factory/shop in accordance with the requirements of Section 09 91 00 - Painting.

   b. Coat polished and non-ferrous metal surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operations.

2. Field Painting: Painting required for exterior surfaces of ductwork and insulation, and finish painting of items only primed at the factory, are specified in Section 09 91 00 - Painting.

END OF SECTION

SCHEDULE

1. Schedule 23 31 14-1 - Metal Duct Construction Standards:

Service	Pressure Classification	Construction Standards
All ductwork on fan discharge side	4" W.G. POS.	SMACNA HVAC Duct Construction Standards
All ductwork on suction side	3" W.G. NEG.	SMACNA HVAC Duct Construction Standards
Transfer air duct not connected to fan	1" W.G. POS. or NEG.	SMACNA HVAC Duct Construction Standards

a. Notes: All accessories, including but not limited to, turning vanes, air turning devices, manual volume dampers, motor operated control dampers, fire dampers, smoke dampers, combination fire and smoke dampers, access doors, supports, angles, clamps, hangers and hardware, shall be suitable for the pressure classification given above.

1) Non-metallic ductwork shall be constructed as specified in Section 23 31 17 - Non-Metal Ducts and Accessories

2. Ductwork Material Schedule:

As shown on the Contract Drawings

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals to furnish and install all fans in accordance with the requirements specified herein, as shown on the Contract Drawings, or specified in the Contract Documents.

B. The equipment shall be furnished complete with all accessories, special tools, spare parts, base attachments, mountings, anchor bolts and other appurtenances as specified or as may be required for a satisfactory installation.

C. All fans shall be furnished in accordance with the schedule shown on the Contract Drawings.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 23 05 48.13 - Vibration Controls for HVAC

C. Section 23 05 53 – Identification for HVAC Piping and Equipment

D. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

E. Section 26 05 91 - Low Voltage Electric Motors

1.04 REFERENCES

A. Equipment shall comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. American Society of Mechanical Engineers (ASME)
2. American Society of Testing Materials (ASTM)
3. Air Movement and Control Association (AMCA)
4. National Electric Code (NEC)
5. The National Fire Code (NFC)
6. Applicable Federal, State and local laws and/or ordinances

B. Where conflict arises between the local codes and the requirements of the National Electrical Code, The National Fire Code, NEMA, ASTM, etc., the more stringent requirements shall prevail.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

B. It is the intent of these Specifications that all components of the fans be provided by the Contractor through one vendor. The Contractor through the vendor shall have the sole responsibility of matching all components and providing equipment which functions together as a system.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings for the approval of the Engineer. Submittals shall include, but not be limited, to the following:

1. Preliminary Operation and Maintenance Manuals
2. Final Operation and Maintenance Manuals
3. Spare Parts List

4. Special Tools List
5. Reports of Certified Shop Tests
6. AMCA Approval for Fan Ratings
7. Shop drawings shall include but not be limited to:
    a. Equipment Specifications and data sheets identifying all materials used and methods of fabrication.
    b. Complete assembly, layout, installation and foundation drawings with clearly marked dimensions.
    c. Fan performance curve indicating the operating point.
    d. Details of corrosion resistance coating.
    e. Motor nameplate data as specified in Section 26 05 19 Low Voltage Electric Motors.
    f. Contract Documents and data sheets for all accessories such as roof curbs, dampers, damper operators disconnect switches, vibration isolators etc.
    g. Example equipment nameplate data sheet.
    h. Interconnecting wiring diagrams.
    i. List of recommended lubricants.

B. Operations and Maintenance Manuals

1. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements of this Contract. Two copies of a preliminary O&M manual shall be included in the Shop Drawing submittal. Without inclusion of these manuals, the submittal will be considered incomplete and will be returned without review.

C. Lubricants: The manufacturer shall submit a list with a minimum of four (4) manufacturers' standard lubricants which may be used interchangeably for each type of lubricant required. The Contractor shall utilize this list in preparing his comprehensive lubrication survey.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

B. The following spare parts shall be furnished for up to every four (4) same size of fan:

1. One (1) blower with wheel

2. One (1) set bearing and seal
3. One (1) set sheave
4. One (1) shaft
5. Two (2) sets of belts for each belt driven fan

C. Furnish all additional spare parts as recommended by the equipment manufacturers.

D. Spare parts lists, included with the Shop Drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Model SP, Model BSQ, Model SQ, Model RBCF, Model GB, Model TAUB, Model USF, Model CUBE and Model CSP as manufactured by Greenheck, Schofield, WI.

B. Type BAF as manufactured by Twin City Fan & Blower, Plymouth, MN.

C. Model A88 as manufactured by Hartzell Air Movement, Piqua, OH.

D. Barry Blower Type AxiFlo as manufactured by Vaneaxial Upblast, Dayton, OH.

E. Series VR-500 and Series P-413 as manufactured by Heresite, Manitowoc, WI.

F. Loren Cook Co., Springfield, MO

G. Series AWD as manufactured by AWB, Powder Springs, GA.

H. Model VTF Roof Ventilator as manufactured by Aerovent, Minneapolis, MN

I. Air Plastics, Inc., Avon Lake, OH

J. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. FANS - CONDITION OF SERVICE AND DESIGN DATA

1. Fans shall be as specified below and shown on the Contract Drawings. The Contractor shall include, as part of this Work, all supports required. The fans shall be installed where indicated on the Contract Drawings.

2. Performance data for all fans shall be based on tests conducted in accordance with the "Standard Test Code for Centrifugal and Axial Fans" as adopted by the Air Movement and Control Association (AMCA) and shall be licensed to bear the AMCA certified rating seal for both sound and air performance. All fans shall be selected from performance curves and not from rating tables. A copy of the curve, indicating the operating point, shall be submitted for each proposed fan.

3. Unless otherwise indicated, motors shall be of the totally enclosed premium efficiency type. Motors shall not be selected for operation in the service factor range/zone. The maximum brake horsepower required at any point on the performance curve shall not exceed the rated horsepower of the motor.

4. Motors 1/3 HP and less shall be suitable for use with 115V, single phase, 60 Hz electric service. Motors 1/2 HP or larger shall be for use with 460V, three phase, 60 Hz electric service, unless otherwise indicated. Two speed motors shall be two winding type. Motors shall comply with the requirements of Section 26 05 91 – Low Voltage Electric Motors.

5. All fans and damper operators shall each be provided with individual externally mounted disconnect switches. All enclosures shall be NEMA 4X-stainless steel unless otherwise specified.

6. All dampers for roof mounted fans shall be mounted in the mounting pedestal with removable access panel for inspection and servicing of damper and operator. Mounting pedestal shall provide solid ventilator support and a weather tight seal.

7. All fans shall be statically and dynamically balanced at the speed at which the unit is scheduled to operate. Fans with corrosion resistant coatings shall be balanced after being coated.

8. The fans shall be either direct connected or V-belt drive as indicated on the schedule. For motors less than or equal to 10 HP, the V-belt drive shall be selected for 120 percent of rated capacity. For motors larger than 10 HP, the V-belt drive shall be selected for 150 percent of rated capacity. All V-belt drives shall be provided with adjustable sheaves. Exposed V-belt drives shall have removable belt guards with openings to allow for tachometer readings at both drive and fan shafts. Guards shall be so constructed as to allow visual inspection of the belts without removing the guard.

9. Vibration isolators shall be provided in conformance with Section 23 05 48.13 - Vibration Controls for HVAC. Isolators shall have a minimum efficiency of 90 percent. Installation, type, number, and size of isolators shall be in conformance with the manufacturer's recommendations for the frequencies involved.

10. Where indicated on the schedule, explosion proof motors, and AMCA Type A spark resistant construction shall be provided. Fans handling explosive

gases shall have all parts in contact with gas fabricated of non-ferrous materials; bearings shall not be located in the gas stream. Explosion proof fans shall be provided with NEMA 7 explosion proof disconnect switches, explosion proof damper operators, and explosion proof motors.

11. All fan bearings shall be selected for a minimum L-50 life of 100,000 hours at maximum operating speed.

12. All fans shall be provided (inside and outside) with baked on Heresite corrosion resistant coating including all accessories but not limited to the housing, wheels, curbs, liners, dampers, damper access sections.

13. All fan motors shall be provided with high premium energy efficient totally enclosed fan cooled type. Where indicated on the schedule, explosion proof motors and AMCA Type "A" spark resistant construction fans shall be provided.

14. All shafts shall be sized so the first critical speed is at least 20 percent over the maximum operating speed. Close tolerance shall be maintained along the length of the shaft.

15. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

16. Fan manufacturer shall provide sound power ratings in the eight octave bands. Sound power levels shall be based on AMCA Standard 301. Sound power ratings shall be in decibels, referenced to 10-12 watts.

B. IN-LINE CABINET FANS

1. Ceiling mounted exhaust fans shall be of the centrifugal direct or belt drive type. The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be lined with 1/2" acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge.

2. The access for wiring shall be external. The motor disconnect shall be externally mounted. The motor shall be mounted on vibration isolators. The fan wheel(s) shall be of the forward curved centrifugal type, constructed of galvanized steel and dynamically balanced.

3. Direct drive fans shall be provided with solid state speed control as required.

C. CENTRIFUGAL BASE MOUNTED FANS

1. Centrifugal base mounted utility fan shall be airfoil bladed single inlet centrifugal fans.

2. Fans shall be arrangement of No. 9, V-belt driven for floor mounting. Fans shall be of all aluminum construction conforming to AMCA "B" spark resistant construction. Unit shall be electrically grounded in the field by installing Contractor. All hardware shall be Type 316 stainless steel.

3. Wheels to have aluminum back plate, shroud and airfoil blades. Adjustable drive assemblies to have static resistant belts sized with 1.5 service factor on motor horsepower. Provide unit with all aluminum belt guard. Adjustable motor mounting base to be fabricated of 316 stainless steel. Fan bearings to be provided with aluminum lubrication lines extended to a common point on the bearing stand.

4. Fans shall be provided with access door, companion flange, motor operated dampers, and inlet boxes.

5. Stainless steel parts to be mill finish.

6. Fans shall be provided with housed spring type vibration isolation for a minimum of 95 percent isolation efficiency and having spring assemblies with rubber coated springs.

7. The bearing supports shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings, bearings shall be heavy duty, self-aligning pillow block ball bearings, and grease lubricated. Shafts shall be turned, ground, polished and rust protected.

D. IN-LINE SQUARE CENTRIFUGAL FANS

1. In-line square fans shall be of centrifugal belt driven in-line type. The fan housing shall be of the square design constructed of heavy gauge all aluminum and shall include square duct mounting collars.

2. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

3. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

4. Motors and drives shall be mounted out of the airstream with combination motor cover and belt guards. Motors shall be readily accessible for maintenance.

5. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings.

6. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for system balancing.

E. UP-BLAST ROOF MOUNTED CENTRIFUGAL FANS

1. Roof exhaust fans shall be upblast centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and

shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Windbands shall have a rolled bead for added strength and shall be joined to curb caps with a welded seam.

2. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

3. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

4. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be externally mounted within NEMA 4X stainless enclosures. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

5. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb with liner and nailer, dampers and damper access section.

F. ROOF MOUNTED AXIAL TYPE SUPPLY FANS

1. Roof mounted supply fan shall be belt driven and axial type hooded propeller roof fans.

2. Propellers shall be constructed with cast aluminum blades and hubs. Propellers shall be securely attached to fan shafts. All propellers shall be statically and dynamically balanced.

3. Fan hood and base construction shall be aluminum. Hood panels shall be arched with interlocking ribs. Fan bases shall be tall bases. Access doors shall be provided for inspection and service of damper and actuator. Hood support angles shall be heavy gauge galvanized steel. Birdscreens of 1/2" Type 316 stainless steel mesh shall be horizontally mounted in the perimeter of the hood.

4. Drive frame and panel assemblies shall be galvanized steel. Drive frames shall be formed channels and fan panels shall have a deep formed inlet venturi.

5. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be fully machined cast iron, keyed and securely attached to propeller and motor shafts. Motor sheaves shall be adjustable for system balancing.

6. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb with liner and nailer, dampers and damper access section.

G. ROOF MOUNTED AXIAL TYPE EXHAUST FAN

1. Fans shall conform to the layout as shown on the drawings. Motor horsepowers and inlet and outlet velocities shall not be exceeded.

2. Fans shall be constructed of low carbon steel and painted with corrosion resistant coating. The inspection shall include welding, dimensions, bearings and overall workmanship.

3. Wheels shall be die-formed cast aluminum type.

4. Shafts shall be AISI C1045 hot rolled steel turned, ground and polished. The shaft's first critical speed shall be at least 140 percent of the fan's maximum operating speed.

5. Wheels shall be dynamically balanced, individually to ANSI S2.19, G6.3. Assembled fans shall then be dynamically balanced using a vibration analyzer to measure velocity. The final reading shall not exceed 0.1 inches per second at the fan shaft speed. The exact level of vibration will be recorded on the fan as proof of the final dynamic balance.

6. The accessories shall include, but not be limited to, belt guard, weather cover, quick open access door, drain, companion flanges, inlet screen, discharge screen, shaft seal, discharge cap, curb cap, spark resistant construction and vibration isolators in accordance with the requirements specified herein and as shown on the Contract Drawings.

7. Housings shall be constructed of heavy gauge steel, structurally reinforced and suitably braced to prevent vibration or pulsation, and shall be arc welded throughout. Lifting lugs shall be welded to the housing to facilitate handling of the fans. Straightening vanes shall be supplied on vaneaxial fans to convert the helical airflow pattern to a smooth straight flow as it leaves the wheel to improve pressure characteristics and eliminate resonant noise.

H. IN-LINE CENTRIFUGAL STAINLESS STEEL FANS

1. Fans shall be V-belt or direct driven with companion angle rings for inlet and outlet ductwork. The motor shall be mounted on a continuously welded motor base that is perpendicular to the fan housing, supported by four (4) adjustable riser bolt assemblies.

2. The fan housing shall be minimum gauge 10 commercial quality 316 stainless steel suitable for temperatures up to 200 F. The inner housing shall be totally enclosed to protect the fan bearings and belts. The inner housing shall be supported to the outer housing by means of air straightening guide vanes. The housing and the wheels shall be continuously welded in

compliance with ASME standards. All accessories exterior to the air stream shall be epoxy coated, i.e., motor base and belt guard.

3. The wheels shall be type BAF air foil industrial quality 316 stainless steel blades having non-overloading horsepower characteristics. The wheels shall be mounted to the fan shaft with a split taper bushing.

4. The shafts shall be ground and polished. Fan bearings shall be grease lubricated with external fittings. The fan bearings shall be heavy-duty, self-aligning ball or roller type depending on the fan size, motor horsepower, and performance, and relubricable for continuous service. The belts shall be oil, heat and static resistant type oversized for continuous duty. Variable pitch drives shall be provided as standard up to and including fans with 10 horsepower motors. Fans shall be complete with suspension clips or support legs as required, companion flanges and spring type vibration isolators.

I. ROOF MOUNTED CENTRIFUGAL FANS

1. Roof mounted fans shall be centrifugal belt or direct drive type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

2. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength.

3. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished with the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance.

4. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

5. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.

6. A fan conduit chase shall be provided through the curb cap to the motor compartment for ease of installation.

7. Each fan shall bear a permanently affixed manufacturer’s nameplate containing the model number and individual serial number for future identification.

8. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb, dampers and damper access section.

    a. For pitched standing seam metal roofing installations, fans shall be provided with base rails. Base rails mounted on structural channels provided by structural Contractor. Refer to structural drawings for mounting details.

J. TUBE AXIAL UPBLAST ROOF EXHAUST FAN

1. Roof mounted upblast exhaust fans shall be of the belt drive tube axial type.
2. Propeller construction shall be cast aluminum airfoil. A standard square key or tapered bushing shall lock the propeller to the shaft. Propellers shall be statically and dynamically balanced.
3. Fan housings shall be constructed of welded heavy gauge steel to assure no air leakage.
4. Bearing supports shall be constructed of structural steel members to prevent vibration and rigidly support the shaft and bearings. All structural steel parts shall be coated with corrosion resistant to provide a lasting finish.
5. Close tolerances shall be maintained where the shaft makes contact with the bearing. Bearings shall be heavy duty, grease lubricated, self-aligning ball type in pillow block mounts. Extended lubrication lines shall be provided with external grease fittings.
6. Windbands shall be constructed of heavy gauge steel with reinforced edges.
7. Curb caps shall be constructed of heavy gauge steel with a prepunched mounting flange and integral venturi inlet.
8. Fans shall be provided with 12" high insulated prefabricated heavy gauge aluminum roof curb, dampers and damper access section.
9. Tube axial upblast roof exhausters shall be supplied as shown on the plans and in the fan schedule.

K. TUBULAR CENTRIFUGAL INLINE DUCT FANS

1. General: Fan shall be factory assembled and tested unit complete with fan wheel, fan shaft, bearings, drive, motor and accessories as specified below. Capacity shall be as scheduled on the Contract Drawings.
2. Materials and Construction:

    a. In-line tubular centrifugal exhaust fans of all aluminum construction with straightening vanes, flanged inlet and outlet connections and support brackets for mounting. Wheel shall be air foil design, non-overloading, statically and dynamically balanced and venturi shaped intake rim. Inner tube construction welded to housing with access plate for servicing and isolation of bearings and drive from air stream.

b. Accessories for fans shall consist of hinged access doors, inlet and outlet flanges, and belt guards.

c. Fan shall have direct or V-belt drive with an adjustable pitch motor pulleys. Pulleys shall be cast steel sized for a 1.2 service factor.

d. The entire fan housing, blades, and all accessories shall be coated with minimum 3 coats (5 mil DFT).

3. Motors shall be ball bearing drive, mounted on an adjustable platform outside the air stream. Motor HP and electrical characteristics shall be as scheduled on the Contract Drawings.

4. Belt guard shall be totally enclosed. Lubrication may be oil or grease type. Integral overload protection, factory mounted and wired unfused disconnects shall be provided for all single phase motors.

L. WALL MOUNTED PROPELLER FANS

1. Type: Wall mounted, propeller fan.

2. Capacity: As specified in the Equipment Schedule on the Contract Drawings.

3. Construction: Steel Wall Fan:

a. Propellers:

1) Airfoil design.

2) Cast aluminum alloy or heavy gauge steel material.

3) Statically and dynamically balanced.

4) Six blades.

5) Propellers equipped with malleable iron split-taper bushing for alignment and locking of propeller to the shaft.

a) Bushing held in place by compression and keyed to the shaft to prevent slipping or loosening.

b) Positioned with three standard capscrews for easy assembly and disassembly.

b. Venturi and Panel:

1) Heavy gauge steel.

2) Designed for airfoil propellers.

c. Safety Guard:

1) 1/2 inch by 1/2 inch PVC coated mesh wire screen that meets OSHA standards.

2) Removable sections to provide for easy access to motor.

d. Damper: None.

4. Accessories:
   a. All structural steel used for mounting fans shall be corrosion resistant coated. Mounting hardware shall be steel.
   b. The Contractor to provide additional stiffeners, angles and supports as required to mount the fans.
5. Drive:
   a. Direct or belt drive as shown on the Contract Drawings.
   b. OSHA approved guard.
6. Painting:
   a. All external and internal metal surfaces of fans, guards, (except propellers and motors) shall be factory primed and factory painted in accordance with Section 09 90 00 - Painting and Coating.
   b. Propellers shall be factory coated with a 4 coat baked phenolic coating system minimum of 2 to 3 mils dry film thickness total.

M. FIBERGLASS AXIAL ROOF FANS
1. Type: Roof mounted, Belt drive axial fan with stack cap and butterfly gravity damper and curb base.
2. Capacity: As scheduled on the Contract Drawings.
3. Construction:
   a. Housing:
      1) Polyester resin reinforced with cloth and mat with integral flanges.
      2) The bearing, base and drive enclosure shall be supported by gussets interlocked into and taped to the outer housing. These structural parts shall all be of laminated glass and resin.
      3) All parts in contact with the air stream shall be constructed of solid fiberglass reinforced plastic using fire retardant resin.
   b. Wheel:
      1) Constructed using a hand lay-up method.
      2) Glass cloth shall be cut to various template sizes to form laminations which are to be fitted into a mold.
      3) Glass shall be impregnated with resin in a step-by-step process.
      4) The fan wheel shall be cured under pressure in the mold forming a monolithic structure.

c. Shaft:

1) Type 316 stainless steel.

2) Machined and keyed with the end drilled and tapped.

3) The wheel shall be held tightly against the shaft shoulder by a stainless steel bolt in the end of the shaft.

4) Stainless steel set screws shall be used to hold the key in place.

d. Shaft Seal:

1) The ends of the bearing and shaft enclosure shall have cover plates sealed into place with an inert silicone rubber sealant.

2) The propeller end cover plate shall be fitted with viton or butyl shaft seal and stainless steel retainer plate.

e. Bearings:

1) The bearings shall be sealed pillow block type with grease tubes extending to the outside of the fan housing.

2) The bearings, shaft and drive shall be enclosed to protect them from air stream contaminants.

f. Motor Base: A steel motor base with slide rail arrangement for belt adjustment shall be bolted between wide gussets integral with flanges of the fan housing.

g. Exterior housing of fan and all accessories shall be factory painted in accordance with Section 09 90 00 - Painting and Coating.

h. Exterior surfaces of the FRP fan, shall be factory painted with an epoxy enamel finish equal to Tnemec. Primer coat shall be Tnemec 66 Epoxoline. Finish coat shall be Tnemec 71 Endurashield. Paint shall be factory applied with touch-up painting in the field as required.

4. Drive: Direct or belt drive as shown on the Contract Drawings.

5. Prefabricated Roof Curb:

a. Weatherproof (slope base type for fans located on sloped roof) continuous welded aluminum construction.

b. Insulated with 1-1/2 inch minimum rigid board fiberglass.

c. Provide treated wood nailer on top of curb with gasket.

d. Twelve inch curb height measured from finished roof to top of wood nailer on high side of roof slope or flat roof.

e. Curb to Roof Deck Fasteners: Cadmium plated lag screws or cadmium plated bolts.

f. Refer to architectural Drawings for curb flashing details.

g. Curb shall be furnished from the same fan manufacturer.

6. Accessories: All furnished from the same fan manufacturer.

a. Stainless steel bolts and nuts.

b. Fiberglass curb base.

c. Fiberglass stack cap.

d. OSHA motor/drive cover - weatherproof.

7. Coatings: Exterior surfaces of the FRP fan, shall be factory painted with an epoxy enamel finish equal to Tnemec. Primer coat shall be Tnemec 66 Epoxoline. Finish coat shall be Tnemec 71 Endurashield. Paint shall be factory applied with touch-up painting in the field as required.

N. FIBERGLASS INLINE AXIAL FLOW DUCT FANS

1. Type: Direct or belt driven, FRP construction duct fan, as shown on the Contract Drawings.

2. Capacity: As scheduled on the Contract Drawings.

3. Construction:

a. Solid FRP construction for corrosive air handling service. Metal components to be coated with corrosion proof paint.

b. Flanged inlet and outlet connections with bolt holes. Provide viton or butyl Gaskets (minimum 1/4 inch thick) at flexible connections to fan inlet and outlet.

c. Single piece solid fiberglass wheel, minimum six blades.

d. Wheel statically and dynamically balanced.

e. Greaseable ball bearings, external grease fittings, L-10 minimum life rating of 40,000 hours at maximum rated rpm.

f. Type 316 stainless steel shaft with EPDM slinger, viton or butyl rubber seal and fiberglass coverplate.

g. Type 316 stainless steel hardware.

h. Motor mounted on fan housing, adjustable mounting. Drive compartment sealed off securely from any leakage of corrosive fumes.

i. Accessories:

1) OSHA approved belt guard.

2) Corrosion resistant coated steel mounting feet, inlet and discharge flanges with bolt holes.

4. Drive: Direct or belt drive.

5. Belt Guard: FRP cover for belt and motor, OSHA approved with tachometer hole.

6. Access Doors:

   a. Conform to housing curvature.

   b. Gasketed (viton or butyl).

7. Mounting Supports: Provide Type 316 stainless steel support brackets and hardware for fan mounting.

O. FIBERGLASS CENTRIFUGAL UPBLAST ROOF FANS

1. Type: Belt driven, FRP construction duct fan, as shown on the Contract Drawings.

2. Capacity: As scheduled on the Contract Drawings.

3. Construction:

   a. Structural parts located in the airstream shall be either fiberglass resin or epoxy coated stainless steel.

   b. All fiberglass surfaces shall be constructed of polyester resin and glass fiber with antimony trioxide added to achieve Class I flame spread below 25.

   c. All fiberglass surfaces shall be protected with a minimum 10 mil thickness of chemical, flame, and ultraviolet resin. The entire housing shall have a finish coat of resin to provide protection and smooth airflow. All airstream hardware shall be 316 stainless steel. All hardware outside the airstream shall be 316 stainless steel.

   d. Fan assembly shall be provided with veil and electric grounding.

   e. The fan housing shall be constructed of fiberglass with a rigid internal support structure.

   f. The fan wheel shall be centrifugal backward inclined, constructed of solid fiberglass to provide non-loading, efficient operation. The wheel shall have a totally encapsulated aluminum core insert for secure attachment to the shaft. The wheel shall be one-piece and suitable for temperatures up to 125 deg F.

   g. Fan shaft shall be precision ground and polished 316 stainless steel. Bearings shall be heavy-duty, self-aligning ball bearings with a minimum 50,000 hours L10 life. A neoprene shaft seal shall be placed where the shaft leaves the housing.

   h. Drive frame assembly shall be constructed of heavy gauge steel and mounted on vibration isolators.

   i. Drive:

      1) Motor pulleys shall be adjustable for final system balancing.

2) Motors and drives shall be mounted on vibration isolators, protected from the airstream.

3) Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants.

4) Motors shall be readily accessible for maintenance.

5) Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

j. Controls:

1) A disconnect switch shall be externally mounted within NEMA 4X stainless enclosures.

2) A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

k. Accessories:

1) Fans shall be provided with an 18-inch high insulated pre-fabricated FRP wind rated roof curb with damper shelf and FRP motor operated damper assembly. Damper assembly shall be Class 1 with an air leakage rate not greater than 4 cfm per square foot of damper surface at 1.0 inch water gauge and shall be labeled by an approved agency when tested in accordance with AMCA 500D for such purpose.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. IDENTIFICATION

1. Each unit of equipment shall be identified with the equipment item numbers given on the Contract Drawings or as directed by the Engineer. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

3.02 INSTALLATION

A. The fans shall be installed, connected and placed in proper working order in accordance with the manufacturer's instructions and details, and the Contract Drawings.

3.03 FIELD TESTING / QUALITY CONTROL

A. TESTING

1. All tests shall be performed in accordance with the requirements of the Contract Documents. Motor tests in accordance with Section 26 05 91 – Low Voltage Electrical Motors.

2. Field tests shall be performed in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

B. MANUFACTURER'S REPRESENTATIVE

1. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The services of the manufacturer's representative shall be provided for a period indicated and as specified in the Contract Documents.

2. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident Engineer each day he is at the Project.

3. Training:

a. The Contractor shall provide training for City personnel. The Contractor shall include in his request for manufacturer approval a certification that the manufacturer has been advised of the stringent requirements for training, and that the costs associated with said training submittals and training have been included in the manufacturer's pricing.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install, and test intake and relief vents, complete and operational.

B. The following index of this Section is presented for convenience:

C.

D. All air outlet and inlets shall be provided in accordance with the schedule shown on the Contract Drawings.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. This Section includes requirements for providing air outlets and inlets as well as accessories in accordance with applicable standards and regulations. In addition:

1. Air outlets and inlets shall be furnished complete with all accessories, special tools, spare parts, mountings, anchor bolts, and other appurtenances as specified and/or required for proper installation.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with the applicable provisions of the standards organizations and regulatory agencies, below:

1. Underwriters Laboratories, Inc.
2. National Fire Protection Association.
3. National Electrical Code.
4. Local and State Building Codes and Ordinances:
   a. Building Code of the State of New York.
   b. New York State Uniform Fire Prevention and Building Code.
   c. New York State Energy Conservation Code.

B. Qualifications of Manufacturer:

1. All components of the air outlets and inlets shall be provided by the Contractor through a single air outlet and inlet vendor.
   a. The vendor shall engage manufacturer(s) which can show successful experience in the fabrication and manufacture of the equipment specified herein.
      1) The manufacturer(s) shall (each) have at least five (5) years' experience in the installation of Work specified.
   b. The Contractor (through the air outlet and inlet vendor), shall have the sole responsibility of matching all components and providing equipment which functions together as a system.
2. The air outlets and inlets shall be the standard equipment of the manufacturer(s).

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

B. Manufacturer's literature, illustrations, specifications, and Engineering data including:

1) Dimensions.

2) Materials of construction.

3) Details of installation.

4) Prefabricated curb details.

5) Air velocity through throat (fpm).

6) Air pressure drop through unit (in. W.G.).

b. Drawings showing:

1) The general arrangement of the equipment and methods of installation with detailed mounting information.

c. Documentation from the factory substantiating painting systems in accordance with the specifications. Include types applied and dry film thicknesses. Include color chart for color selection.

d. Operation and maintenance manuals

2. Information Submittals:

a. Spare parts list

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation and packing of the air outlets and inlets for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The air outlets and inlets shall be handled in such a manner that they may be transported and unloaded without being over-stressed, deformed, or otherwise damaged.

2. The air outlets and inlets shall be protected from corrosion and deterioration and shall be stored in a dry area.

a. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with effective and durable waterproof covers approved by the Engineer.

3. Interiors shall be kept free from dirt and foreign matter.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair and adjust the equipment provided under this Section, and as per the requirements of the Contract Documents and/or as recommended by the manufacturer.

B. Tools: Provide standard and special tools and supplies necessary to service, disassemble, repair, and adjust the equipment.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All products provided under this Section shall be covered by a ten (10) year manufacturer warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Air outlets and inlets:

1. Multitier Louver Type TR (intake vent) and Type TRE (relief vent), as manufactured by Loren Cook Company, Powder Springs GA;
2. Model FGI (intake vent) and Model FGR (relief vent) as manufactured by Greenheck Fan Corporation, Valley Forge, PA;
3. Multitier Gravity Louvered Penthouse Ventilators, Model TIL, as manufacturer by Twin City Fan and Blower, Minneapolis, MN.
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Air Intake and Relief Vents:

1. Capacity: As shown on the Contract Drawings.
2. General:
   a. Provide low contour, rectangular or square hood type, as shown on the Contract Drawings.
   b. Provide multitier louver type as shown on the Contract Drawings.
3. Construction:
   a. Housing:
      1) Spun aluminum construction reinforced to withstand wind forces without damage.
      2) Housings for intake and relief units shall be of similar in finish and color to match roof mounted fans in appearance.
   b. Base:
      1) One-piece spun aluminum or welded aluminum construction.

B. Accessories:

1. Dampers: Opposed-blade, aluminum construction. Dampers shall be Motor Operated or Gravity Operated as shown on the Contract Drawings.

2. Bird Screen: ½-in. (13 mm) mesh Type 316 stainless steel screen securely anchored to housing at air outlet. Provide type 316 insect screen where shown on the Contract Drawings.

3. Curb Gasket: Self-adhesive gasket of Buna-N, EPDM, or Hypalon cemented to inner edge of curb to provide air and water seal between curb and housing.

4. Base to Curb Fasteners: Type 316 stainless steel lag screws and bolts.

5. Prefabricated Roof Curb:

a. Weatherproof, continuous welded minimum 14 ga. aluminum construction.

b. Insulated with 2-in. minimum fiberglass sandwiched between inner and outer walls of curb.

c. 45° canted type sides.

d. Provide curb with gasket as per above and wood blocking to mount curb. Provide flashing and counter flashing at curb as required to make watertight installation.

e. 12-in. minimum curb height measured from finished roof to top of pressure treated wood nailer.

f. Curb to Roof Deck Fasteners: Type 316 stainless steel lag screws and bolts.

g. Refer to architectural Contract Drawings for curb flashing details.

h. Contractor shall furnish prefabricated roof curbs from the same manufacturer as the air intakes and relief vents.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting:

1. All exterior and interior surfaces of equipment, including all accessories, shall be coated with a dry phenolic coating system.

a. Finish and color to match housing.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspection:

1. The Contractor shall not install damaged items until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.
    a. Only minor repair work will be permitted in the field.
    b. All damaged items requiring remedial work shall be returned to the manufacturer for repair or replacement

B. Examine curbs to receive air intake and relief vents for:
1. Horizontal mounting surface.
2. Water tightness.
3. Proper anchoring and flashing of prefabricated curb to roof deck.
4. Unevenness, irregularities, and incorrect dimensions that would affect quality and execution of installation.

C. Do not proceed with installation of air intake and relief vents until curbs conform to Contract requirements.

3.02 INSTALLATION

A. Roof openings and penetrations shall be capped to prevent weather from entering building prior to installation of air intakes or relief vents.

B. Install air outlets and inlets in complete accordance with manufacturer's printed installation instructions and the approved shop drawings.

C. Anchor base to wood nailer on curb with lag screws or bolts in manner that allows for easy removal for damper service.

D. Check proper connections for electrical wiring hook-ups for motorized dampers.

3.03 FIELD TESTING / QUALITY CONTROL

A. Furnish the services of a qualified manufacturer's representative to check and approve all installations before operation, in accordance with the requirements of the Contract Documents. In addition:
1. The Contractor shall verify that all Work furnished and installed conforms to the requirements the Contract Documents.
2. Verify that the unit is secured to supports, and that duct connections are complete.
3. Verify that cleaning is complete.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting:

1. Upon completion of the installation, the Contractor shall adjust all air intake and relief vents for their intended use.

B. Protection:

1. The air outlets and inlets shall be protected as per the requirements of the Contract Documents. The use of the air outlets and inlets shall not be permitted until permission is given by the Engineer.

C. Cleaning:

1. In addition to the requirements of the Contract Documents, the Contractor shall thoroughly remove all debris and waste materials resulting from installation.
2. Clean tar, dirt, and marks from exterior of units.
3. Touch up all chips in factory finishes.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 05 48.13 – Vibration Controls for HVAC

B. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

C. Section 23 31 14 – Metal Ducts and Accessories

D. Section 26 05 20 – Low-Voltage Wires, Cables, and Accessories

E. Section 26 05 27 – Grounding

F. Section 26 05 53 – Identification for Electrical Systems

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Section includes packaged, rooftop air conditioning units (RTUs) with the following components:

1. Unit Casings.
2. Fans, drives, and motors.
3. Coils.
4. Refrigerant circuit components.
5. Air filtration.
6. Electrical power connections.
7. Controls.
8. Accessories.
9. Materials.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each RTU.
    a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
    b. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
    c. Include unit dimensions and weight.
    d. Include cabinet material, metal thickness, finishes, insulation, and accessories.
    e. Fans:
        1) Include certified fan-performance curves with system operating conditions indicated.
        2) Include certified fan-sound power ratings.
        3) Include fan construction and accessories.
        4) Include motor ratings, electrical characteristics, and motor accessories.

f. Include certified coil-performance ratings with system operating conditions indicated.

g. Include filters with performance characteristics.

h. Include gas furnaces with performance characteristics.

i. Include factory selection calculations for each antimicrobial ultraviolet lamp installation.

j. Include dampers, including housings, linkages, and operators.

2. Shop Drawings: For each packaged, rooftop air-conditioning units.

a. Include plans, elevations, sections, and mounting details.

b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

c. Include diagrams for power, signal, and control wiring.

3. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

b. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

c. Wind-Restraint Details: Detail fabrication and attachment of wind restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

B. Informational Submittals

1. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

2. Sample Warranty: For manufacturer's warranty.

3. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 23 05 48.13 "Vibration Controls for HVAC."

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Source quality-control reports.

5. System startup reports.

6. Field quality-control reports.

C. Closeout Submittals

1. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

D. Maintenance Material Submittals

1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters: One set of filters for each unit.

b. Gaskets: One set for each access door.

c. Fan Belts: One set for each belt-driven fan.

d. Filters: One set of filters for each unit.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Model CyberPack as manufactured by Stulz Air Technology Systems Inc., Frederick, MD

B. Model WHC as manufactured by Trane, La Crosse, WI

C. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Performance Requirements

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
3. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
4. ASHRAE 15 Compliance: For refrigeration system safety.
5. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
    a. Delegated Design: Engage a qualified Professional Engineer, as defined in Section 01 40 00 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
        1) Design RTU supports to comply with wind performance requirements.

B. Unit Casings

a. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

b. Double-Wall Construction:

1) Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

2) Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick, perforated 40 percent free area.

3) Floor Plate: G90 galvanized steel, treadplate, minimum 18 gauge.

4) Casing Insulation:

a) Materials: Injected polyurethane foam insulation.

b) Casing Panel R-Value: Minimum <Insert value>.

c) Insulation Thickness: 1 inch.

d) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

c. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

d. Static-Pressure Classifications:

1) For Unit Sections Upstream of Fans: Minus 3-inch wg.

2) For Unit Sections Downstream and Including Fans: 4-inch wg.

e. Panels and Doors:

1) Panels:

a) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

b) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.

c) Gasket: Neoprene, applied around entire perimeters of panel frames.

d) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

2) Access Doors:

a) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.

b) Gasket: Neoprene, applied around entire perimeters of panel frames.

c) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

3) Locations and Applications:

a) Fan Section: Inspection and access panels.

b) Access Section: Doors.

c) Coil Section: Inspection and access panels.

d) Damper Section: Inspection and access panels.

e) Filter Section: Doors large enough to allow periodic removal and installation of filters.

f) Mixing Section: Doors.

f. Condensate Drain Pans:

1) Location: Each type of cooling coil.

2) Construction:

a) Double-wall, galvanized-steel or noncorrosive polymer sheet with space between walls filled with foam insulation and moisture-tight seal.

3) Drain Connection:

a) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

b) Minimum Connection Size: NPS 1.

4) Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

5) Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.

6) Width: Entire width of water producing device.

7) Depth: A minimum of 2 inches deep.

8) Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.

9) Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

C. Fans, Drives, and Motors

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

2. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.

e. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

f. Shaft Lubrication Lines: Extended to a location outside the casing.

g. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch- thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

3. Drives, Direct: Factory-mounted, direct drive.

4. Drives, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

c. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- thick, diamond-mesh wire screen, welded to steel angle frame; prime coated.

5. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated ECM motors.

6. Motors:

a. Motor Sizes: Minimum size as indicated in Contract Drawings. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

1) Enclosure Type: Open, dripproof.

2) Enclosure Materials: Cast iron.

3) Motor Bearings: Sealed ball or roller bearings.

4) Efficiency: Premium efficient as defined in NEMA MG 1.

5) NEMA Design: Design B.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

D. Coils

1. General Requirements for Coils:

a. Comply with AHRI 410.

b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

c. Coils shall not act as structural component of unit.

2. Supply-Air Refrigerant Coil:

a. Tubes: Copper.

b. Fins:

1) Material: Aluminum.

2) Fin Spacing: Maximum 12 fins per inch.

c. Fin and Tube Joints: Mechanical bond.

d. Headers: Seamless-copper headers with brazed connections.

e. Frames: Galvanized steel.

f. Coatings: Corrosion-resistant coating.

g. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum 300 psig.

3. Electric-Resistance Heating Coils: Comply with UL 1995.

a. Casing Assembly: Slip-in type with galvanized-steel frame.

b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

e. Control Panel: Unit mounted with disconnecting means and overcurrent protection.

1) Magnetic contactor.

2) Solid-state, stepless pulse controller.

3) Toggle switches, one per step.

4) Step controller.

5) Time-delay relay.

6) Pilot lights, one per step.

7) Airflow proving switch.

E. Refrigerant Circuit Components

1. Compressor: Hermetic, variable speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

2. Refrigeration Specialties:

a. Refrigerant: R-410A.

b. Expansion valve with replaceable thermostatic element.

c. Refrigerant filter/dryer.

d. Manual-reset high-pressure safety switch.

e. Automatic-reset low-pressure safety switch.

f. Minimum off-time relay.

g. Automatic-reset compressor motor thermal overload.

h. Brass service valves installed in compressor suction and liquid lines.

i. Low-ambient kit high-pressure sensor.

j. Hot-gas reheat solenoid valve single stage with a replaceable magnetic coil.

k. Hot-gas bypass solenoid valve with a replaceable magnetic coil.

l. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

F. Air Filtration

1. Panel Filters:

a. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.

b. Filter Unit Class: UL 900.

c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.

d. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

2. Bag Filter:

a. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.

b. Filter Unit Class: UL 900.

c. Media: Fibrous material, with antimicrobial coating, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.

d. Filter-Media Frame: Galvanized steel.

3. Cartridge Filters:

a. Description: Factory-fabricated, adhesive-coated disposable, packaged air filters with media perpendicular to airflow, and with holding frames.

b. Filter Unit Class: UL 900.

c. Media: Fibrous material, with antimicrobial coating, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.

d. Filter Media Frame: Galvanized steel.

G. Electrical Power Connections

1. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

H. Controls

1. Controller:

a. Controller shall have volatile-memory backup.

b. Controller shall have LCD user interface with the following functionality:

1) Adjusting set points.

2) Monitoring supply fan start, stop, and operation.

3) Inquiring data to include supply- and room-air temperature.

4) Monitoring occupied and unoccupied operations.

5) Monitoring constant and variable motor loads.

6) Monitoring variable-frequency drive operation.

7) Monitoring cooling load.

8) Monitoring air-distribution static pressure and ventilation air volume.

c. Normal Operation:

1) A temperature sensor furnished by RTU manufacturer and field installed by installing HVAC Contractor shall be space mounted and shall transmit a proportional control signal to a corresponding controller to automatically maintain space temperature.

d. Safety Control Operation:

1) Smoke Detectors: Stop fan if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.

2) Firestats: Stop fan if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.

3) Fire Alarm Control Panel Interface: Provide control interface.

4) Low-Discharge Temperature: Stop fan if supply air temperature is less than 40 deg F.

2. Interface Requirements for HVAC Instrumentation and Control System:

a. Interface relay for scheduled/automatic or manual operation at the central HVAC control panel.

b. Interface relay to provide indication of faults and alarms at the central HVAC control panel and diagnostic code storage.

I. Accessories

1. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

3. Safeties:

a. Smoke detector.

b. Condensate overflow switch.

c. Phase-loss reversal protection.

d. High and low pressure control.

e. Electric coil airflow-proving switch.

4. Coil guards of painted, galvanized-steel wire.

5. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

6. Outdoor air intake weather hood with moisture eliminator.

7. Service Lights and Switch: Factory installed in each accessible section with weatherproof cover. Factory wire lights to a single-point field connection.

J. Materials

1. Steel:

a. ASTM A36/A36M for carbon structural steel.

b. ASTM A568/A568M for steel sheet.

2. Stainless Steel:

a. Manufacturer's standard grade for casing.

b. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

3. Galvanized Steel: ASTM A653/A653M.

4. Aluminum: ASTM B209

5. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a [3000] <Insert time>-hour salt-spray test according to ASTM B117.

a. Standards:

1) ASTM B117 for salt spray.

2) ASTM D2794 for minimum impact resistance of 100 in-lb.

3) ASTM B3359 for cross-hatch adhesion of 5B.

b. Application: Immersion.

c. Thickness: 1 mil.

d. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. AHRI Compliance:

1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Unit Support: Install unit level on structural steel supports. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

C. Piping Connections

1. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Where installing piping adjacent to RTU, allow space for service and maintenance.
3. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

D. Duct Connections

1. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
2. Connect supply and return ducts to RTUs with flexible duct connectors specified in Section 23 31 14 "Metal Ducts and Accessories."

E. Electrical Connections

1. Connect electrical wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
2. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
3. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
4. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
5. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 26 05 53 "Identification for Electrical Systems."
6. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.
7. Locate nameplate where easily visible.

F. Control Connections

1. Install control and electrical power wiring to field-mounted control devices.
2. Connect control wiring according to Section 26 05 20 " Low-Voltage Wires, Cables, and Accessories"

3.03 FIELD TESTING / QUALITY CONTROL

A. Testing

1. All tests shall be performed in accordance with the requirements of the Contract Documents.
2. Field tests shall be performed in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

B. Manufacturer’s Representative

1. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The services of the manufacturer's representative shall be provided for a period indicated and as specified in the Contract Documents.
2. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's

representative shall sign in and out at the office of the Resident Engineer each day they are at the Project.

3. Training:

a. The Contractor shall provide training for personnel. The Contractor shall include in his request for manufacturer approval a certification that the manufacturer has been advised of the stringent requirements for training, and that the costs associated with said training submittals and training have been included in the manufacturer's pricing.

3.04 STARTUP / DEMONSTRATION

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Inspect for visible damage to unit casing.

D. Inspect for visible damage to compressor, coils, and fans.

E. Inspect internal insulation.

F. Verify that labels are clearly visible.

G. Verify that clearances have been provided for servicing.

H. Verify that controls are connected and operable.

I. Verify that filters are installed.

J. Clean condenser coil and inspect for construction debris.

K. Remove packing from vibration isolators.

L. Verify lubrication on fan and motor bearings.

M. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

N. Adjust fan belts to proper alignment and tension.

O. Start unit according to manufacturer's written instructions.

P. Start refrigeration system.

Q. Do not operate below recommended low-ambient temperature.

R. Complete startup sheets and attach copy with Contractor's startup report.

S. Inspect and record performance of interlocks and protective devices; verify sequences.

T. Operate unit for an initial period as recommended or required by manufacturer.

U. Calibrate thermostats.

V. Adjust and inspect high-temperature limits.

W. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

X. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

1. Coil leaving-air, dry- and wet-bulb temperatures.
2. Coil entering-air, dry- and wet-bulb temperatures.
3. Outdoor-air, dry-bulb temperature.
4. Outdoor-air-coil, discharge-air, dry-bulb temperature.

Y. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

Z. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

1. Supply-air volume.
2. Return-air volume.
3. Relief-air volume.
4. Outdoor-air intake volume.

AA. Simulate maximum cooling demand and inspect the following:

1. Compressor refrigerant suction and hot-gas pressures.
2. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

BB. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems and after completing startup service, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete

B. Section 07 72 46 - Roof Walkways

C. Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 19 – HVAC Piping Insulation

F. Section 23 09 00 - Instrumentation and Controls Scope and General Requirements

G. Section 23 09 13 - Instrumentation and Control Devices for HVAC

H. Section 23 09 14 - Control Panels, Enclosures and Devices for HVAC.

I. Section 23 21 13 – Hydronic Piping

J. Section 23 21 16 – Refrigerant Piping

K. Section 23 31 14 – Metal Ducts and Accessories

L. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories

M. Section 26 05 27 – Grounding

N. Section 26 05 33 – Raceways and Boxes for Electrical Systems

1.04 REFERENCES

A. Air-Conditioning and Refrigeration Institute (ARI): ARI 1230 - Performance Rating of Variable Refrigerant Flow Multi-Split Air-Conditioning and Heat Pump Equipment

B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

1. ASHRAE 15 - Safety Standard for Refrigeration Systems

2. ASHRAE 51 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

3. ASHRAE 52 - Method of Testing General Ventilation Air-Cleaning Devices for Removal efficiency by Particle Size

C. American National Standards Institute (ANSI) / Air Movement and Control Association International, Inc. (AMCA):

1. ANSI/AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

2. ANSI/AMCA 300 - Reverberant Room Method for Sound Testing of Fans

3. ANSI/AMCA 500 - Laboratory Methods of Testing Dampers for Rating

D. ASTM International (ASTM):

1. ASTM B117 - Salt Spray Testing Standards

E. National Electrical Manufacturers Association (NEMA):

1. NEMA ICS 1 General Standards for Industrial Control and Systems

F. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC)

G. Underwriters' Laboratories, Inc., (UL):

1. UL 1025 - Electric Air Heaters
2. UL 1995 - Heating and Cooling Equipment

1.05 A. DESCRIPTION

A. Section includes complete variable refrigerant flow (VRF) HVAC system(s) including, but not limited to delegated design and the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, exposed, wall-mounted units.
2. Indoor, recessed, ceiling-mounted units.
3. Outdoor, air-source, heat-pump units.
4. System controls.
5. System refrigerant and oil.
6. System condensate drain piping.
7. System refrigerant piping.
8. Metal hangers and supports.
9. Piping and tubing insulation.
10. System control cable and raceways.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of **five** years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least **five** completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
   a. Product research and development.
   b. Product and application engineering.

c. Product manufacturing, testing, and quality control.

d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.

e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.

2. In-place facility located within 50 miles of Project.

3. Demonstrated past experience with products being installed for period within **five** consecutive years before time of bid.

4. Demonstrated past experience on **five** projects of similar complexity, scope, and value.

a. Each person assigned to Project shall have demonstrated past experience.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.

6. Service and maintenance staff assigned to support Project during warranty period.

7. Product parts inventory to support ongoing system operation for a period of not less than **five** years after Substantial Completion.

8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

2. Installer certification shall be valid and current for duration of Project.

3. Retain copies of Installer certificates on-site and make available on request.

4. Each person assigned to Project shall have demonstrated past experience.

a. Demonstrated past experience with products being installed for period within **five** consecutive years before time of bid.

b. Demonstrated past experience on **five** projects of similar complexity, scope, and value.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.07 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.

b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

c. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.

d. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.

e. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit control.

f. Include description of control software features.

g. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.

h. Include refrigerant type and data sheets showing compliance with requirements indicated.

i. For system design software.

j. Indicate location and type of service access.

2. Shop Drawings: For VRF HVAC systems.

a. Include plans, elevations, sections, and mounting details.

b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

c. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported

equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

d. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.

e. Include diagrams for power, signal, and control wiring.

3. Delegated-Design Submittals:

a. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

b. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.

c. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.

d. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

B. Informational Submittals

1. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Suspended ceiling components.

b. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.

c. Size and location of initial access modules for acoustical tile.

d. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.

e. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.

f. Items penetrating finished ceiling including the following:

1) Luminaires.

2) Air outlets and inlets.

3) Speakers.

4) Service access panels.

2. Qualification Data:

a. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

1) Retain copies of Installer certificates on-site and make available on request.

b. For VRF HVAC system manufacturer.

c. For VRF HVAC system provider.

3. Product Certificates: For each type of product.

4. Product Test Reports: Where tests are required, for each product, test reports performed by manufacturer and witnessed by a Nationally Recognized Testing Laboratory (NRTL).

5. Source quality-control reports.

6. Field quality-control reports.

7. Sample Warranties: For manufacturer's warranties.

C. Closeout Submittals

1. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

2. Software and Firmware Operational Documentation:

a. Software operating and upgrade manuals.

b. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.

c. Device address list.

d. Printout of software application and graphic screens.

D. Maintenance Material Submittals

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters:

1) One set(s) for each unit with replaceable filters.

2) One set(s) for each unit type and unique size of washable filters.

b. Indoor Units: One for each unique size and type installed.

c. Controllers for Indoor Units: One for each unique controller type installed.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Indoor & Outdoor Units

1. Model Multi V Indoor & Outdoor Units as manufactured by LG Electronics USA Inc., Englewood Cliffs, NJ

2. Or approved equal

3. Source Limitations: For each building, obtain products from single source from single manufacturer including, but not limited to, the following:
   a. Indoor and outdoor units, including accessories.
   b. Controls and software.
   c. Refrigerant isolation valves.
   d. Specialty refrigerant pipe fittings.

B. Automatic Condensate Pumps
1. Model EC-1K-DV automatic condensate pumps as manufactured by Little Giant Pump Co., Oklahoma City, OK
2. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. System Description
a. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
   1) Two-pipe system design.
   2) System operation as indicated on Drawings.
   3) Each system with one refrigerant circuit shared by all indoor units connected to system.
b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
c. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
d. ASHRAE Compliance:
   1) ASHRAE 15: For safety code for mechanical refrigeration.
   2) ASHRAE 62.1: For indoor air quality.
   3) ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
e. UL Compliance: Comply with UL 1995.

B. Performance Requirements

1. Service Access:
   a. Provide and document service access requirements.
   b. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
   c. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
   d. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
   e. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
   f. Comply with OSHA regulations.
2. System Design and Installation Requirements:
   a. Design and install systems indicated according to manufacturer's recommendations and written instructions.
   b. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
3. Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.
4. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
   a. Not less than 50 percent.
   b. Not more than 130 percent.
   c. Range acceptable to manufacturer.
5. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.
6. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

7. Outdoor Conditions:
    a. Suitable for outdoor ambient conditions encountered.
        1) Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.
        2) Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.
        3) Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.
    b. Maximum System Operating Outdoor Temperature: 95 deg F.
    c. Minimum System Operating Outdoor Temperature: 9 deg F.
8. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
    a. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
    b. Outdoor: Within ordinance of governing authorities.
9. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.
10. Capacities and Characteristics: As indicated on Drawings.

C. Indoor, exposed, wall-mounted units
1. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
2. Cabinet:
    a. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
    b. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
    c. Mounting: Manufacturer-designed provisions for field installation.
    d. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

3. DX Coil Assembly:
    a. Coil Casing: Aluminum, galvanized, or stainless steel.
    b. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
    c. Coil Tubes: Copper, of diameter and thickness required by performance.
    d. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
    e. Unit Internal Tubing: Copper tubing with brazed joints.
    f. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
    g. Field Piping Connections: Manufacturer's standard.
    h. Factory Charge: Dehydrated air or nitrogen.
    i. Testing: Factory pressure tested and verified to be without leaks.
4. Drain Assembly:
    a. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
    b. Condensate Removal: Gravity.
        1) If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
    c. Field Piping Connection: Non-ferrous material.
5. Fan and Motor Assembly:
    a. Fan(s):
        1) Direct-drive arrangement.
        2) Single or multiple fans connected to a common motor shaft and driven by a single motor.
        3) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
        4) Wheels statically and dynamically balanced.
    b. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
    c. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

d. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

e. Vibration Control: Integral isolation to dampen vibration transmission.

6. Filter Assembly:

a. Access: Front, to accommodate filter replacement without the need for tools.

b. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

7. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.

8. Unit Accessories:

a. Condensate Pump: provide condensate pump, reservoir, level on/off sensors and overflow protection switch with electrical power connection through unit power. Provide line set cover and mounting brackets for pump.

9. Unit Controls:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Factory-Installed Controller: Configurable digital control.

c. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.

d. Field-Customizable I/O Capability:

1) Analog Inputs: Four for use in customizable control strategies.

2) Digital Inputs: Four for use in customizable control strategies.

3) Digital Outputs: Four for use in customizable control strategies.

e. Features and Functions: Self-diagnostics, time delay, auto-restart, external static pressure control, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.

f. Communication: Network communication with other indoor units and outdoor unit(s).

g. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

h. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

10. Unit Electrical:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Field Connection: Single point connection to power entire unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

D. Indoor, recessed, ceiling-mounted units.

1. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

2. Cabinet:

a. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

b. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

c. Mounting: Manufacturer-designed provisions for field installation.

d. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

3. DX Coil Assembly:

a. Coil Casing: Aluminum, galvanized, or stainless steel.

b. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

c. Coil Tubes: Copper, of diameter and thickness required by performance.

d. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

e. Internal Tubing: Copper tubing with brazed joints.

f. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

g. Field Piping Connections: Manufacturer's standard.

h. Factory Charge: Dehydrated air or nitrogen.

i. Testing: Factory pressure tested and verified to be without leaks.

4. Drain Assembly:

a. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

b. Condensate Removal: Factory installed, unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.

c. Field Piping Connection: Non-ferrous material.

5. Fan and Motor Assembly:

a. Fan(s):

1) Direct-drive arrangement.

2) Single or multiple fans connected to a common motor shaft and driven by a single motor.

3) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.

4) Wheels statically and dynamically balanced.

b. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

c. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

d. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

e. Vibration Control: Integral isolation to dampen vibration transmission.

6. Filter Assembly:

a. Access: Bottom, to accommodate filter replacement without the need for tools.

b. Efficiency: ASHRAE 52.2, MERV 7.

c. Media:

1) Washable: Manufacturer's standard filter with antimicrobial treatment.

7. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

a. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.

1) Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.

2) Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

b. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

c. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.

8. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

9. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

10. Unit Accessories:

a. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

11. Unit Controls:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Factory-Installed Controller: Configurable digital control.

c. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.

d. Field-Customizable I/O Capability:

1) Analog Inputs: Four for use in customizable control strategies.

2) Digital Inputs: Four for use in customizable control strategies.

3) Digital Outputs: Four for use in customizable control strategies.

e. Features and Functions: Self-diagnostics, time delay, auto-restart, external static pressure control, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.

f. Communication: Network communication with other indoor units and outdoor unit(s).

g. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

h. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

12. Unit Electrical:

a. Enclosure: Manufacturer's standard, and suitable for indoor locations.

b. Field Connection: Single point connection to power entire unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

E. Outdoor, air-source, heat-pump units.

1. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
    a. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
    b. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
    c. All units installed shall be from the same product development generation.
2. Cabinet:
    a. Galvanized steel and coated with a corrosion-resistant finish.
        1) Coating with documented salt spray test performance of 1000 hours according to ASTM B117 surface scratch test (SST) procedure.
    b. Mounting: Manufacturer-designed provisions for field installation.
    c. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
3. Compressor and Motor Assembly:
    a. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
    b. Protection: Integral protection against the following:
        1) High refrigerant pressure.
        2) Low oil level.
        3) High oil temperature.
        4) Thermal and overload.
        5) Voltage fluctuations.
        6) Phase failure and phase reversal.
        7) Short cycling.

c. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.

d. Vibration Control: Integral isolation to dampen vibration transmission.

e. Oil management system to ensure safe and proper lubrication over entire operating range.

f. Crankcase heaters with integral control to maintain safe operating temperature.

g. Fusible plug.

4. Condenser Coil Assembly:

a. Plate Fin Coils:

1) Casing: Aluminum, galvanized, or stainless steel.

2) Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.

3) Tubes: Copper, of diameter and thickness required by performance.

b. Aluminum Microchannel Coils:

1) Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.

2) Single- or multiple-pass arrangement.

3) Construct fins, tubes, and header manifolds of aluminum alloy.

c. Coating: Corrosion resistant.

5. Condenser Fan and Motor Assembly:

a. Fan(s): Propeller type.

1) Direct-drive arrangement.

2) Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.

3) Statically and dynamically balanced.

6. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
7. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
8. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
9. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
10. Vibration Control: Integral isolation to dampen vibration transmission.
11. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
12. Unit Controls:
    a. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
    b. Factory-Installed Controller: Configurable digital control.
    c. Factory-Installed Sensors:
        1) Refrigerant suction temperature.
        2) Refrigerant discharge temperature.
        3) Outdoor air temperature.
        4) Refrigerant high pressure.
        5) Refrigerant low pressure.
        6) Oil level.
    d. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, equalize run time between multiple same components.
    e. Communication: Network communication with indoor units and other outdoor unit(s).
    f. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
    g. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
13. Unit Electrical:

a. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.

b. Field Connection: Single point connection to power entire unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

14. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

15. Unit Piping:

a. Unit Tubing: Copper tubing with brazed joints.

b. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

c. Field Piping Connections: Manufacturer's standard.

d. Factory Charge: Dehydrated air or nitrogen.

e. Testing: Factory pressure tested and verified to be without leaks.

F. System controls.

1. General Requirements:

a. Network: Indoor units and outdoor units shall include integral controls and connect through a TIA-485A or manufacturer-selected control network.

b. Network Communication Protocol: Manufacturer proprietary or open control communication between interconnected units.

c. Operator Interface:

1) Operators shall interface with system and unit controls through the following:

a) Operator interfaces integral to controllers.

b) Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

(1) On/off control.

(2) Temperature set-point adjustment.

2. Wired Controllers for Indoor Units:

a. Single controller capable of controlling multiple indoor units as group.

b. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.

c. Temperature Units: Fahrenheit.

d. On/Off: Turns indoor unit on or off.

e. Hold: Hold operation settings until hold is released.

f. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.

g. Temperature Display: 1-degree increments.

h. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.

i. Relative Humidity Display: 1 percent increments.

j. Relative Humidity Set-Point: Adjustable in 1 percent increments.

k. Fan Speed Setting: Select between available options furnished with the unit.

l. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.

m. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.

n. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.

o. Occupancy detection.

p. Service Notification Display: "Filter".

q. Service Run Tests: Limit use by service personnel to troubleshoot operation.

r. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.

s. User and Service Passwords: Capable of preventing adjustments by unauthorized users.

t. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.

u. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

G. System refrigerant and oil.

1. Refrigerant:

a. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

b. ASHRAE 34, Class A1 refrigerant classification.

c. R-410a.

2. Oil:

a. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

H. System condensate drain piping.

1. Refer to Section 23 21 13 – Hydronic Piping for condensate drain piping specifications.

I. Automatic condensate pumps.

1. Source Limitations: Obtain pump units from single source from single manufacturer.

2. Description: Packaged units with corrosion-resistant pump, reservoir with cover, and automatic controls including level on/off sensor and overflow protection switch. Collects and removes condensate from indoor units and similar components. Include factory- or field-installed check valve and 72-inch- minimum, electrical power cord with plug. Electrical power connection through unit power. Provide line set cover and mounting brackets for pump.

J. System refrigerant piping.

1. Refer to Section 23 21 16 – Refrigerant Piping for refrigerant piping specifications.

K. Metal hangers and supports.

1. Refer to Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment for metal hanger and supports specifications.

L. Piping and tubing insulation.

1. Refer to Section 23 07 19 – HVAC Piping Insulation for piping and tubing insulation specifications.

M. System control cable and raceways.

1. Cable Rating: Listed and labeled for application according to NFPA 70.

a. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1) Flame Travel Distance: 60 inches or less.

2) Peak Optical Smoke Density: 0.5 or less.

3) Average Optical Smoke Density: 0.15 or less.

b. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

c. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2. Low-Voltage Control Cabling:

a. Paired Cable: NFPA 70, Type CMG.

1) One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

2) PVC insulation.

3) Braided or foil shielded.

4) PVC jacket.

5) Flame Resistance: Comply with UL 1685.

b. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1) One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

2) PVC insulation.

3) Braided or foil shielded.

4) PVC jacket.

5) NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

6) Flame Resistance: Comply with NFPA 262.

3. TIA-485A Network Cabling:

a. Standard Cable: NFPA 70, Type CMG.

1) Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2) PVC insulation.

3) Unshielded.

4) PVC jacket.

5) Flame Resistance: Comply with UL 1685.

b. Plenum-Rated Cable: NFPA 70, Type CMP.

1) Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2) Fluorinated ethylene propylene insulation.

3) Unshielded.

4) Fluorinated ethylene propylene jacket.

5) NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

6) Flame Resistance: NFPA 262.

4. Comply with requirements in Section 26 05 33 – Raceways and Boxes for Electrical Systems for control wiring and cable raceways.

N. Materials

1. Steel:

a. ASTM A36/A36M for carbon structural steel.

b. ASTM A568/A568M for steel sheet.

2. Stainless Steel:

a. Manufacturer's standard grade for casing.

b. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

3. Galvanized Steel: ASTM A653/A653M.

4. Aluminum: ASTM B209.

5. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

a. Standards:

1) ASTM B117 for salt spray.

2) ASTM D2794 for minimum impact resistance of 100 in-lb.

3) ASTM B3359 for cross-hatch adhesion of 5B.

b. Application: Immersion.

c. Thickness: 1 mil.

d. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Submit shop test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Equipment Installation, General

1. Clearance:

a. Maintain manufacturer's recommended clearances for service and maintenance.

b. Maintain clearances required by governing code.

2. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

a. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

B. Installation of Indoor Units

1. Install units to be level and plumb while providing a neat and finished appearance.

2. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

3. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

4. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

5. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

6. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

7. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.

8. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

9. Floor-mounted units located in mechanical rooms.

C. Installation of Outdoor Units

1. Install units to be level and plumb while providing a neat and finished appearance.

2. Install outdoor units on support structures indicated on Drawings.

3. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 - Cast-in-Place Concrete.

   a. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.

   b. Grouting: Place grout under equipment supports and make bearing surface smooth.

4. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 07 72 00 - Roof Walkways. Anchor units to supports with removable, stainless-steel fasteners.

D. Installation of System Condensate Drain Piping

1. Comply with requirements for condensate drain piping specified in Section 23 21 13 – Hydronic Piping.

E. Installation of Automatic Condensate Pump

1. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

2. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3. Install overflow protection switch per manufacturer's wiring recommendations.

4. For wall mounted indoor units, mount reservoir and condensate pump inside line set cover.

F. Installation of Refrigerant Piping

1. Comply with requirements for refrigerant piping specified in Section 23 21 16 – Refrigerant Piping.

G. Installation of Metal Hangers and Supports

1. Comply with requirements for metal hangers and supports specified in Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment.

H. Installation of Piping and Tubing Insulation

1. Comply with requirements for piping and tubing insulation specified in Section 23 07 19 – HVAC Piping Insulation.

I. Installation of Ducts and Accessories

1. Comply with requirements for metal ducts and accessories specified in Section 23 31 14 – Metal Ducts and Accessories.

J. Electrical Installation

1. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

a. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

2. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

3. Comply with requirements in Section 26 05 20 – Low-Voltage Wires, Cables and Accessories for wiring connections.

4. Comply with requirements in Section 26 05 27 – Grounding for grounding connections.

5. Comply with requirements in Section 26 05 33 – Raceways and Boxes for Electrical Systems for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

K. Installation of System Control Cable

1. Comply with requirements for system control cable specified in Section 23 09 00 - Instrumentation and Controls Scope and General Requirements, Section 23 09 13 - Instrumentation and Control Devices for HVAC, and Section 23 09 14 - Control Panels, Enclosures and Devices for HVAC.

L. Grounding Installation

1. For low-voltage control cabling, comply with requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

M. Identification

1. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 23 05 53 – Identification for HVAC Piping and Equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.04 STARTUP / DEMONSTRATION

A. Startup

1. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
   a. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
   b. Complete startup service of each separate system.
   c. Complete system startup service according to manufacturer's written instructions.
2. Startup checks shall include, but not be limited to, the following:
   a. Check control communications of equipment and each operating component in system(s).
   b. Check each indoor unit's response to demand for cooling and heating.
   c. Check each indoor unit's response to changes in airflow settings.
   d. Check each indoor unit and outdoor unit for proper condensate removal.
   e. Check sound levels of each indoor and outdoor unit.
3. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
   a. Installer shall correct deficiencies found during startup service for reverification.

4. System Operation Report:
    a. After completion of startup service, manufacturer shall issue a report for each separate system.
    b. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
    c. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
        1) All available system operating parameters shall be included in the information submitted.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting
1. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.
2. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
3. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

B. Protection
1. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
2. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
3. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
4. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 23 09 13 – Instrumentation and Control Devices for HVAC

B. Section 26 05 27 – Grounding

C. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

1.04 REFERENCES

A. Reference Standard:

1. ASHRAE The American Society of Heating, Refrigerating and Air-Conditioning Engineers
    a. Standard 62.1 - The Standards for Ventilation and Indoor Air Quality
2. NFPA National Fire Protection Agency
    a. 1. NFPA 70 - National Electrical Code
3. UL Underwriters Laboratory
    a. UL 1996 – Electric Duct Heaters
4. SMACNA Sheet Metal and Air Conditioning Contractors National Association
    a. HVAC Duct Construction Standards.

B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
1. HVAC Duct Construction Standards.

1.05 DESCRIPTION

A. Section includes the following electric-resistance air coils:
1. Electric baseboard heaters
2. Electric duct heaters

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Action Submittals
1. Product Data: For each type of product.
    a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
    b. Include rated capacities, operating characteristics, and pressure drops for each air coil.
2. Shop Drawings: Include diagrams for power, signal, and control wiring.

B. Informational Submittals
1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

C. Closeout Submittals

1. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Electric baseboard heaters:

1. Indeeco, St. Louis, MO
2. Chromalox, Inc., Pittsburgh, PA
3. Brasch Manufacturing Co., Inc., Maryland Heights, MO
4. Or approved other.

B. Electric duct heaters:

1. Renewaire, Waunakee, WI
2. Indeeco, St. Louis, MO
3. Chromalox, Inc., Pittsburgh, PA
4. Or approved other.

2.02 MATERIALS / EQUIPMENT

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. Electric baseboard heaters

1. Coils

a. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency recognized under 29 CFR 1910.7 and marked for intended location and application.

b. Coil Assembly: Comply with UL 1995.

c. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.

2. Housing

   a. Cabinet shall be constructed of 20-gauge galvanized steel with a robust aluminum front cover. The unit shall have a epoxy/polyester powder paint with satin finish in white or metallic charcoal.

3. Inlet/outlet grilles

   a. The fresh air inlet grille shall be located at the bottom of the front of the unit. The outlet shall be located at the top with openings less than 0.25-inches to discourage tampering with the heating element (pencil-proof).

4. Built-in controls

   a. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.

      1) Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

   b. Adjustable thermostat, double pole, 277V Max, 25 Amp with off position

5. Electrical connection

   a. Each baseboard heater shall have a junction box located on both ends and a built-in full length wire way

   b. Factory built-in disconnect switch, 277V Max, double-pole, 16 Amp

C. Electric duct heaters

1. Type: Heaters shall be of the slip-in mount type for duct mounting.

2. Heating Elements:

   a. Open coil of resistance wire, 60 percent nickel, 20 percent chromium, and 20 percent iron supported and insulated by floating ceramic bushings. Heating element support structure shall consist of galvanized steel wire formed and constructed to support ceramic bushings through which the heating element passes.

   b. All heating elements shall be made of nickel/chromium resistance wire with ends terminated by means of staking and heliarc welding to machine screws.

   c. Coil Layout: Vertical (air flow horizontal)

3. Casing Assembly: Slip-in type, galvanized-steel frame

4. Coil terminals shall be nickel plated, terminal insulators and bracket bushings shall be of ceramic and securely positioned.

5. Control Box: Control cabinet shall have a solid cover also of heavy gauge galvanized steel and held in place with hinges and interlocking disconnect switch.

6. Orientation: Heaters shall be interchangeable for mounting in a horizontal or vertical duct.

    a. Heaters up to 60 kW shall be capable of being rotated 180 degrees.

7. Built-in components shall include disconnecting break magnetic contactors, transformer with primary fusing, pressure-type airflow switch set at 0.05 + 0.02 in. w.g. all as required by UL, branch circuit fuses per NEC, interlocking disconnect switch and a single terminal block to accept the number, type and size of conductors as required.

8. Over-Temperature Protection:

    a. Serviceable through electric duct heater without removing heater from duct or unit.

    b. Disk-type, automatic reset, thermal-cutout safety devices for primary over-temperature protection.

    c. Secondary over-temperature protection by built in disc type manually resettable thermal cutouts.

    d. The primary and secondary devices shall function independently of one another and are not acceptable if series connected in the control circuit wiring.

    e. All duct heaters will require either a fan interlock circuit or an airflow switch. The airflow switch shall be diaphragm operated differential pressure switch to prevent duct heater from operating when there is no air flow.

9. A disconnecting magnetic control circuit is required.

10. All wiring, component sizing, component spacing and protective devices within the control cabinet shall be factory installed and comply with NEC and UL standards.

11. Control Panel: Mounted on unit, with means of a safety disconnect and overcurrent protection. Include the following controls:

    a. Magnetic contactor.

    b. Single-stage Silicon Controlled Rectifier (SCR) that shall be capable of accepting 0-10Vdc or 4-20mA as control signal

    c. 24V control voltage

12. A wiring diagram depicting layout and connections of electrical components within the control cabinet shall be affixed to the inside of the control cabinet cover.

13. A rating plate label shall be affixed to the exterior of the control cabinet cover which states model number, serial number, volts, amps, phase, frequency, control volts, volt-amps and minimum airflow requirements.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examination

1. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Electric baseboard heater

1. All installation shall be in accordance with manufacturer's published recommendations.
2. Inspect areas and conditions under which heater units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
3. Do not install heaters beneath a wall outlet.
4. Do not install heater against combustible low-density cellulose fiberboard surfaces.
5. Install coils level and plumb.
6. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

B. Electric duct heater

1. Locate, orient, and connect ductwork per AMCA, ASHRAE, and SMACNA guidelines. Provide service clearances as indicated on the plans. Locate units distant from sound critical occupancies.
2. Provide a structurally suitable support as necessary for all units. Installation shall meet or exceed all applicable federal, state and local requirements,

referenced standards and conform to codes and ordinances of authorities having jurisdiction.

3. Perform all Work required to install the electric duct heaters, with supplementary items necessary for proper installation.

4. All installation shall be in accordance with manufacturer's published recommendations.

5. Inspect areas and conditions under which heater units are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to installer.

6. Do not operate electric heaters for any purpose until ductwork is clean of any possible debris.

7. Maintain minimum working clearances around the heater electrical panel in accordance with NEC Article 110.

8. Install duct heaters in metal ducts and casings constructed according to SMACNA "HVAC Duct Construction Standards."

9. If applicable, anchor duct heaters in position using suitable supports.

10. Connect duct heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.

C. Connections

1. Ground equipment according to Section 26 05 26 – Grounding and Bonding for Electrical Systems.

2. Connect wiring according to Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. After installation is completed, including painting, clean unit's exposed surfaces and vacuum clean electric duct heaters and inside of cabinets.

B. Touch up scratches and marks from handling and placement of equipment with masking enamel to match manufacturer's color. Refer to Section 09 91 00 - Painting for site-applied finishes.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install and test all unit heaters, complete and operational.

B. The following index of this Section is presented for convenience:

C. All unit heaters shall be provided in accordance with the schedule shown on the Contract Drawings.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 23 05 53 – Identification for HVAC Piping and Equipment

C. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

D. Section 26 05 91 – Low-Voltage Electric Motors

E. Section 40 05 97 – Identification for Process Equipment

1.04 REFERENCES

A. Reference Standards

1. ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality
2. NFPA 70 – National Electrical Code (NEC)
3. UL 2021 – Fixed and Location-Dedicated Electric Room Heaters

1.05 DESCRIPTION

A. This Section includes requirements for providing unit heaters and accessories in accordance with applicable standards and regulations. In addition:

1. Unit heaters shall be furnished complete with all accessories, special tools, spare parts, attachments, mountings, anchor bolts, and other appurtenances as specified and/or as may be required for a proper installation.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with applicable provisions of the standards organizations and regulatory agencies, below.

1. American Society of Mechanical Engineers.
2. American Society of Testing Materials.
3. Air Movement and Control Association.
4. Air Conditioning and Refrigeration Institute.
5. National Electrical Code.
6. Standards of the Hydraulic Institute
7. American National Standard Institute.
8. National Fire Protection Association.
9. Applicable Federal, State, and local laws and/or ordinances

B. Qualifications of Manufacturer:

1. All components of the unit heaters shall be provided by the Contractor through a single vendor.

a. The Contractor (through the unit heater vendor) shall have the sole responsibility of matching all components and providing equipment which functions together as a system.

2. The unit heaters shall be standard equipment of the manufacturer.

3. The unit heaters shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

4. Provide units listed by the Underwriters Laboratories, Inc.

C. Regulatory Requirements:

1. The Work of this Section shall be performed by a plumber licensed by the local authority having jurisdiction.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

a. Equipment specifications and data sheets identifying all materials used and methods of fabrication.

b. Complete assembly, layout, and installation drawings with clearly marked dimensions.

c. Fan performance data.

d. Coil performance data.

e. Details of corrosion resistance coating.

f. Weights of assembled units.

g. Motor nameplate data as specified in Section 26 05 91, Low-Voltage Electric Motors.

h. Example equipment nameplate data sheet.

i. Schematic diagrams for electric and control systems showing wiring for individual equipment items and interconnecting wiring diagrams.

j. Shop and field testing procedures.

k. List of recommended lubricants.

l. Operation and Maintenance Manuals.

2. Information Submittals:

a. Spare Parts List.

b. Special Tools List

c. Reports of Certified Shop Tests.

d. List of Lubricants:

1) The manufacturer shall submit a list with a minimum of four (4) manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required.

a) The Contractor shall utilize this list in preparing his comprehensive lubrication survey as described in the Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The cleaning, preservation and packing of the unit heaters for shipment shall be in accordance with the manufacturer's commercial practice.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The unit heaters shall be handled in such a manner that they may be transported and unloaded without being over-stressed, deformed, or otherwise damaged.

2. The unit heaters shall be protected from corrosion and deterioration and shall be stored in a dry area.

a. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with effective and durable waterproof covers approved by the Engineer.

3. Interiors shall be kept free from dirt and foreign matter.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare parts and special tools necessary to service, disassemble, repair and adjust the equipment provided under this Section, and as per the requirements of the Contract Documents and/or as recommended by the manufacturer. In addition:

1. Provide two sets of filters for each cabinet unit heater, properly packed and labeled.

2. Provide one motor for up to every 4 of same size motor for all heaters.

B. Tools: Provide standard and special tools and supplies necessary to service, disassemble, repair, and adjust the equipment.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All products provided under this Section shall be covered by a ten (10) year manufacturer warranty from Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Unit Heaters:

1. Trane Company, Long Island City, NY;
2. Modine Manufacturing Co., Racine, WI;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Unit Heaters:

1. General:
   a. The unit heater shall be complete with:
      1) Hot water coil.
      2) Fan.
      3) Motor.
      4) Fan Guard.
      5) Louver Fin Diffuser (for horizontal unit heaters).
      6) Casing.
   b. Each unit shall be provided with mounting bracket.
2. Coating:
   a. The entire unit including coil shall be coated internally and externally with a corrosion resistant phenolic coating.
   b. The coating on the entire unit shall be baked on.
3. Coils:
   a. The coils shall be constructed of aluminum fins permanently bonded to seamless copper tubes.
   b. The coils shall be suitable for pressure up to 200 psig and entering water temperatures up to 325°F inclusive.
   c. Coils shall be tested at a minimum of 300 psig air pressure under water.
4. Casing: The casing shall be constructed of heavy gauge steel.
5. Fan Wheels:
   a. Fan wheels shall consist of heavy gauge aluminum propeller type blades, statically and dynamically balanced at the speed at which the unit is scheduled to operate.
6. Drive:
   a. The fan shall be direct driven by a resiliently mounted, single speed, totally enclosed motor.
7. Motor:

a. Explosion-proof motors shall be provided where shown on the schedule on the Contract Drawings.

B. Cabinet Heaters:

1. General:

a. Provide cabinet heaters of the minimum size, heating and air capacities and arrangement shown.

2. Heating Element:

a. Shall be constructed of seamless copper tubes hydraulically expanded into aluminum plate fins to give a permanent bond.

3. Cabinets:

a. Construct cabinets of heavy gauge bonderized sheet steel, with a baked enamel finish of a standard color selected.

1) Construct front panels of die formed steel, with top inlet and bottom discharge grilles.

4. Blowers:

a. Construct blowers of aluminum, of the forward curved, centrifugal, double width, double inlet type, balanced to give quiet operation.

5. Motor and Drive:

a. Provide the permanent split capacitor type motor, 3-speed, with automatic overload protection and resilient base.

b. Provide the motor of the direct drive type with lubricated bearings, and with the speed selector switch mounted inside the cabinet.

6. Accessories:

a. Provide units complete with 1-in. thick fiberglass disposable type air filters, arranged for easy removal and replacement.

C. Electric Unit Heaters:

1. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

a. Provide unit mounted factory-installed power disconnect switch.

1) 15-Amp for heaters rated 12-Amps or lower

2) 30-Amp for heaters rated between 13- to 24-Amps

3. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

4. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

6. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

7. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

8. Fan: Aluminum propeller directly connected to motor.

9. Motor: Permanently lubricated.

10. Factory installed and prewired control options are to be supplied: adjustable built-in thermostat, fan only switch, pilot light to indicate abnormal operation.

D. Explosion-Proof, Electric Unit Heaters:

1. Explosion proof, electric unit heaters shall be fan-forced type, UL Approved for Class I, Divisions 1 and 2, Group C and D; Class II, Divisions 1 and 2, Groups E, F and G.

2. Assembly including chassis, liquid-to-air heating coil, fan, motor, and controls. Comply with UL 2021.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   a. Provide unit mounted factory-installed power disconnect switch.

      1) 15-Amp for heaters rated 12-Amps or lower

      2) 30-Amp for heaters rated between 13- to 24-Amps

4. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

5. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

8. The heat exchanger shall be liquid-to-air design, utilizing a steel tube core with integral aluminum fins. Nontoxic, inhibited, propylene glycol heat transfer fluid shall be used that provides freeze protection down to -49 deg F.

    a. A Pressure relief plug shall be utilized to provide overpressure protection. The heat exchanger shall include industrial grade electric heating elements.

9. Fan: Aluminum propeller directly connected to motor.

10. Motor: motor shall include permanently lubricated ball bearings and built-in thermal overload protection. Motor to operate at line voltage and be prewired to the control enclosure to eliminate the need for separate field wiring to the motor.

11. Factory installed and prewired control options are to be supplied: adjustable built-in thermostat, fan only switch, pilot light to indicate abnormal operation.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Identification:

1. Provide in accordance with Section 23 05 53, Identification for HVAC Piping and Equipment and Section 40 05 97, Identification for Process Equipment.

2. Each unit of equipment shall be identified with the equipment item numbers shown on the Contract Drawings.

3. A corrosion resistant tag and nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification.

B. Coatings:

1. All exterior and interior metal surfaces of unit heaters (except coils) shall be factory primed and factory painted in accordance with Section 09 91 00, Painting.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. All unit heaters shall be as efficient as those have been tested to perform satisfactorily for at least two (2) years and providing equipment, which functions together as a system.

B. Shop Tests:

1. All shop tests shall be witnessed by a licensed Professional Engineer.

2. The licensed Professional Engineer shall sign and seal all test reports.

a. The state of the Professional Engineer's registration, the Professional Engineer's license number, and the Professional Engineer's name on the seal shall be clearly legible.

3. Procedure:

a. Shop test motors in accordance with Section 26 05 91, Low-Voltage Electric Motors.

b. Coils shall be shop tested at a minimum of 300 psig air pressure under water.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspection:

1. The Contractor shall not install damaged items until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.

a. Only minor repair work will be permitted in the field.

b. All damaged items requiring remedial work shall be returned to the manufacturer for repair or replacement.

3.02 INSTALLATION

A. Install unit heaters in complete accordance with the manufacturer's printed installation instructions and the approved shop drawings.

3.03 FIELD TESTING / QUALITY CONTROL

A. Furnish the services of a qualified manufacturer's representative to check and approve all installations before operation in accordance with the requirements of the Contract documents. In addition:

1. The Contractor shall verify that all work furnished and installed conforms to the requirements of the Contract Documents.

B. All tests shall be performed in accordance with Section 23 05 93, Testing, Adjusting and Balancing for HVAC.

3.04 STARTUP / DEMONSTRATION

A. Furnish the service of a qualified manufacturer representative to assist and train the plant operations and maintenance staff in the care, operation, and maintenance of the unit heaters in accordance with the requirements of the Contract Documents. In addition:

1. The Contractor shall make all adjustments required to place Work in proper operating condition.

2. The Contractor shall include instruction on care and maintenance of the convectors in the training of plant personnel.

3. In the event of trouble with the equipment, the manufacturer's representative shall revisit the Site as often as required until all troubles are corrected and the installation is entirely satisfactory.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting:

1. Upon completion of the installation, the Contractor shall adjust all the unit heaters for their intended use.

2. Set air deflectors for proper air delivery.

3. Check room thermostat and wiring connections to unit heater.

4. Check return air thermostat and connections to cabinet unit heater.

B. Protection of Finished Work:

1. Unit heaters shall be protected as per the requirements of the Contract Documents. The use of unit heaters shall not be permitted until permission is given by the Engineer.

a. When permission is given, the Contractor shall operate each convector to ensure their performance.

C. Cleaning:

1. In addition to the requirements of the Contract Documents, the Contractor shall thoroughly clean all surfaces of the installed unit heaters and remove all debris and waste materials resulting from installation.

2. Clean work as specified in the Contract Documents.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials and equipment required to perform the Work in accordance with the general electrical requirements as specified under this Section and shown on the Contract Drawings.

B. The Work shall also include the following:

1. Inserts and other electrical items which shall be installed embedded in concrete, or built into walls, partitions, ceilings, or panels constructed by Other Contractor(s).

2. Installation procedures and schedules under other contracts shall be reviewed and coordinated with Other Contractor(s) regarding the installation of electrical items that must be installed.

3. Keep informed of the construction so the electrical work shall be installed within such time periods as will not delay the work of the Other Contractor(s).

4. Notify Other Contractor(s) in advance of the installation of the work included, so they shall have sufficient time for coordination and installation of interrelated items that are included in their contracts and that must be installed in conjunction with the work included under this Contract.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 41 00 – Regulatory Requirements

B. Section 09 91 00 - Painting.

1.04 REFERENCES

A. NFPA 70E - Standard for Electrical Safety in the Workplace

B. NFPA 101 - Life Safety Code

C. NEC - National Electrical Code

D. NYS Building Codes - New York State Building Codes

E. OSHA 1910 Subpart S - General Industry Standards Subpart S Electrical

F. Con Edison EO-2022

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. All equipment and devices, provided under each Contract, shall be properly connected, and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Sections or shown on the Contract Drawings.

B. Contractor shall comply with latest Con Edison version of EO-2022.

C. Similar products shall be by the same manufacturer for uniformity on the Contract.

D. Electrical material and equipment shall be new and shall bear the label of UL, or other nationally recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.

E. Where execution of the work under this Contract requires certain systems and equipment to be modified, the Contractor shall perform the work with due regard

to maintenance of operations and construction staging in accordance with the Specifications.

F. The modification work shall be coordinated in advance with the shaft superintendent and existing conditions. Contractor shall field determine and make such investigations as required to determine the functionality of each circuit and identify circuit terminations as required for the modifications intended to ensure the proper interface of all components for a complete functional system.

G. The Contractor shall retain the services of a wiring coordinator, to prepare the point-to-point field wiring diagrams. The wiring coordinator shall have experience in the development of the diagrams of the type specified and shall have served in a similar role on a project of similar size and complexity.

H. Area Classifications

1. Materials and equipment for all indoor areas shall conform to the area classifications shown on the Contract Drawings or stated in the Specifications.

2. Materials and equipment for all outdoor areas shall conform to corrosive requirements, unless shown otherwise on the Contract Drawings or stated in the Specifications.

3. The locations and requirements shall be in accordance with the following:

a. Materials, equipment, and incidentals installed in corrosive areas shall meet NEC, local codes, and NEMA requirements for corrosive locations. Enclosures installed in corrosive locations shall meet NEMA 4X requirements.

b. Materials, equipment, and incidentals installed in hazardous locations shall meet NEC, local codes requirements for the Class and Division designated. Enclosures installed in hazardous locations shall be provided with stainless steel hardware and watertight gasketing.

c. Materials, equipment, and incidentals installed in dusty locations shall meet NEC, local codes and NEMA 12 requirements.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited, to:

1. All Con Edison-related required drawings, catalog cuts, shop drawings, calculations, test procedures, test results, test reports, inspection reports, etc. to Engineer and Con Edison for review and approval.

2. Point-to-point field wiring diagrams.

3. Qualifications of proposed wiring coordinator who shall prepare the point-to-point field wiring diagrams.

B. Reports

1. Demonstration of equipment report shall be submitted.

C. Electrical Plan Approvals

1. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the AHJ. The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government building department, and Con Edison.

D. Third Party Approvals

1. Consolidated Edison Company: The Contractor shall be responsible for coordinating with Con Ed and submit electrical catalog cut sheets, layouts and plans for Con Ed service equipment including, but not limited to, the electrical equipment related to the Con Ed services, manholes, ductbanks/cables, connections/splices, and the interim/temporary and permanent service transformers, grounding, and metering cabinets. Contractor shall also be responsible for obtaining final Con Ed approval on the equipment prior to installation. See Section 01 41 00 – Regulatory Requirements for more requirements of Contractor and Con Edison coordination.

2. Communication Services Company: The Contractor shall be responsible for coordinating with the Telecommunication Service Companies, and submit equipment cut sheets, layouts, and plans for Telecommunication Service Companies equipment including, but not limited to, the service manholes, ductbanks/cables, connections/splices, and other related equipment. Contractor shall also be responsible for obtaining final Communications approval on the equipment prior to installation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Point-To-Point Field Wiring Diagrams

1. The Contractor shall provide point-to-point field wiring diagrams for all equipment, including equipment provided by Other Contractor(s).

2. The diagrams shall be developed for performance of the work and to document terminations. The diagrams shall be prepared based upon approved shop drawings of related Contracts and inspections as necessary to complete the diagrams. The diagrams shall include:

a. External wiring for each piece of equipment, panel, instrument, and other devices to control stations, lighting panels and motor controllers. The diagrams shall include control, status, signal, and power wiring. Power diagrams shall include connections to switchgear, motor control centers, panelboards, panels, and field devices.

b. Numbered terminal block identification for each wire termination.

c. Identification of the assigned wire numbers and color coding for all interconnections.

d. Identification of all wiring by the conduit tag in which the wire is installed.

e. Terminal, junction, and pull boxes through which wiring is routed.

f. Identification of equipment with functional name and number to which wiring is to be connected.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Shop Finishes

1. Electrical equipment shall be shop painted in accordance with the requirements of Section 09 91 00- Painting.

2. Exposed ferrous metal surfaces except aluminum, bronze, brass, and stainless-steel components shall be cleaned with a commercial blast and primed with one coat of rust inhibitive primer.

3. Manufactured assemblies such as switchgear, substations, motor control centers, panelboards and motor controllers shall be shop painted in accordance with the requirements of Section 09 91 00 - Painting.

4. Other equipment shall be painted with the manufacturer's best grade finish paint system compatible with the finish coatings specified in Section 09 91 00 - Painting.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Maintenance of Operations

1. Where execution of the work under this Contract requires certain equipment to be taken out of service, the Contractor shall perform the work with due regard to maintenance of operations and construction staging in accordance with the Specifications.

2. The Contractor shall schedule the work in advance with the Engineer so as not to affect proper plant operations. When the work is scheduled, the Engineer shall be notified forty-eight (48) hours prior to proceeding with the work to allow time for the plant superintendent to perform load switching and alternation of equipment.

3. To the maximum extent possible at the end of the workday, all equipment shall be back in place and ready for its normal service use should a shaft emergency arise. In addition, should an emergency condition occur during execution of the work, at the request of the shaft engineer, the equipment shall be placed back in service immediately and turned over to plant personnel.

4. In the event of accidental shutdown of Shaft equipment, the Contractor shall notify plant personnel immediately to allow for an orderly restart of affected equipment.

3.02 INSTALLATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall demonstrate, in the presence of the Engineer that all electrical systems and electrically operated equipment operates as specified, designed, and as required.

B. The Contractor shall coordinate the demonstration of the electrical systems that are part of other contracts with the Other Contractor(s).

C. The demonstration of equipment shall include the following:

1. All power circuits shall be operated to verify proper connection to equipment. Mechanical key-interlocks for circuit breakers shall be operated to verify their proper operation. Power shall be removed and reapplied to automatic transfer switches to verify their operation.

2. Emergency power systems shall be activated to verify their automatic start-up, proper operation while running and proper deenergization and cool down upon availability of normal power.

3. All pushbuttons, indicating lights and similar devices shall be operated to verify proper connection and function. All devices, such as pressure and flow switches and similar devices shall be operated to verify that shutdowns and control sequences operate as required.

4. The Contractor, with coordination of the Other Contractor(s), shall operate the systems to verify wiring and adjust the controls, as required, to achieve proper operation. This shall include wiring, timing, and switching functions.

D. The Contractor shall provide a demonstration of equipment report. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, and all other pertinent information.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Restoration

1. The Contractor shall field paint after installation marred or scratched surfaces. All scratches, abrasions, and other damage to equipment shall be touch-up painted in accordance with the requirements of Section 09 91 00 - Painting.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing medium-voltage cables and accessories.

1. Medium-voltage cables and accessories shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. Medium-Voltage cables to be provided shall include all accessories.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements.

B. Section 26 05 27 - Grounding.

C. Section 26 05 53 - Labelling and Identification.

D. Section 26 06 11 - Cable and Conduit Schedules.

1.04 REFERENCES

A. Definitions

1. Medium-voltage as used in this Section and the Specifications shall mean all voltages greater than 1000 volts.

2. Medium-voltage cable is an assembly of single or multiple insulated conductors combined with fillers and separators in an enclosing jacket of insulating material.

3. Medium-voltage cables shall mean all insulated electric wires and cables intended for use for medium-voltage circuits.

4. Medium-voltage cable accessories shall mean all devices and items intended to provide mechanical and electrical protection, terminate, connect, splice, insulate, tag, and manage medium-voltage cables in the proposed installation.

5. All references to the Electric Utility or Utility shall mean Consolidated Company or the local Electric Utility having jurisdiction.

B. Reference Standards: Medium-voltage cables shall comply with the latest applicable provisions and recommendations of the following:

1. AEIC CS8 - Specification for Extruded Dielectric, Shielded Power Cables Rated 5 through 46 kV.

2. ASTM B496 - Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

3. ICEA S-93-639/NEMA WC74 - Standard for Shielded Power Cables Rated 5-46 kV for the Distributions of Electrical Energy.

4. IEEE C2 - National Electrical Safety Code.

5. IEEE 48 - IEEE Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations

6. IEEE 400 - IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.

7. IEEE 576 - IEEE Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications

8. IEEE 1210 - IEEE Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable

9. NETA ATS - NETA Acceptance Testing Specifications.
10. NEMA WC 26/EEMAC 201 - Binational Wire and Cable Packing Standard
11. NEC - National Electrical Code
12. NYS Building Codes - NYS Building Codes
13. UL 1072 - Standard for Medium-Voltage Power Cables
14. NIST - National Institute of Standards and Technology

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. All medium-voltage cables shall be made by an approved single manufacturer, and in their construction shall be employed the most improved commercial materials and processes of manufacture.

B. Only new medium-voltage cable manufactured under high standards of production and meeting the approval of the Engineer shall be used.

C. Medium-voltage cable and accessories shall comply with the requirements of the serving Electric Utility.

D. All medium-voltage cable splicing and terminations shall be done by experienced cable splicers who have worked with similar cable for a period of at least five (5) years, using materials and procedures recommended by the cable manufacturer.

E. All splicing and terminations of medium-voltage cable shall be in accordance with the instructions of the cable manufacturer.

F. The medium-voltage cable manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration of testing apparatus shall be within one year.

G. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and NETA ATS.

H. The Contractor shall retain the services of the medium-voltage cable manufacturer's representative to certify that the cable installation is in accordance with the manufacturer's requirements.

I. Field Tests:

1. Medium-voltage cables shall be field tested. Field testing for shall be in accordance with the requirements specified in this Section.
2. The Contractor shall retain the services of an independent testing firm who shall perform acceptance testing on the medium-voltage cable installation. The testing firm shall have experience in the inspection and testing of cables

of the type proposed for installation and shall be a member company of NETA. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers shall be submitted with the products they produce proposed for the contract. Manufactures selected shall comply with Section 01 43 05 - Contractor's Work Quality.

2. Manufacturer's Literature, specifications and engineering data for the medium-voltage and cables and accessories including but not limited to:

a. Manufacturer and type of cable.

b. Voltage and temperature rating.

c. Conductor material, size, number, and size of strands composing each conductor.

d. Conductor shield material, type, and thickness in inches.

e. Insulation material, insulation thickness in inches, insulation type, percentage level.

f. Insulation shield material, type, and thickness in inches

g. Metallic shield material and thickness in inches.

h. Sheath and or jacket material and thickness in inches.

i. Minimum insulation resistance in megaohms per 1,000 ft. at 20 degrees C.

j. Average outside diameter of bare conductor.

k. Average outside diameter of finished cable and sheath or jacket material.

l. Weight per 1,000 ft. of finished cable.

m. Minimum bending radius of the cable, in inches.

n. Minimum pulling temperatures at which cable may be pulled without damage.

o. Maximum pulling tensions which may be applied to the cable without damage.

p. Literature identifying the methods, tools, and materials which Contractor proposes to use to make splices and terminations.

Submittal shall consist of manufacturer's literature evidencing compatibility of the conductor insulation, shield, and jacket of the cable with the splicing or terminating materials and methods which Contractor proposes to use.

q. Manufacturer recommended pulling lubricants.

r. Qualifications of splicing and termination personnel.

3. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least forty-five (45) days in advance prior to conformation of witness testing dates and actual testing.

4. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least forty-five (45) days in advance to actual testing, five (5) recent references with phone numbers shall be submitted.

5. Qualifications of proposed cable installer shall be submitted. Submit installer experience records with five (5) recent completed installations with names and phone numbers.

6. Certification from medium-voltage cable manufacturer's representative that the medium-voltage cable installation is in accordance with the manufacturer's requirements.

B. Reports:

1. Shop and field test reports shall be submitted.

2. Acceptance testing report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Medium-voltage cables shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's instructions.

2. Deliver medium-voltage cables on factory reels conforming to NEMA WC26. Each end of each length of cable shall be hermetically sealed with the manufacturer’s end caps and securely attached to the reel. Reels with unsealed ends will be rejected.

3. Inspect cable protective coverings for evidence of damage during shipment.

4. Accomplish unloading without contacting cable surface or protective coverings or dropping cable reels from the delivering vehicle to the ground.

B. Storage

1. Store cables on reels on elevated hard surfaces in clean dry locations away from construction equipment, falling objects, sources high heat and chemicals or petroleum products.
2. Seal cut cable ends using properly sized heat shrink cap to prevent moisture ingress and wicking into the cable interior.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Medium-Voltage cable shall be as manufactured by
1. Okonite Company, Orangeburg, SC;
2. Kerite Company, Seymour, CT;
3. Or approved equal.

B. Connectors shall be as manufactured by:
1. Thomas and Betts, Memphis, TN;
2. Burndy, Manchester, NH;
3. Or approved equal.

C. Terminations shall be as manufactured by:
1. Elastimold – Thomas and Betts, Memphis TN;
2. G&W Electric, Bolingbrook, IL;
3. Raychem Corporation, Chicago, IL;
4. 3M – St. Paul, MN;
5. Or approved equal.

D. Splices shall be manufactured by:
1. Elastimold – Thomas and Betts, Memphis TN;
2. G&W Electric Company, Bolingbrook, IL;
3. Raychem Corporation, Chicago, IL;
4. 3M- St. Paul, MN;
5. Or approved equal.

E. Fireproofing Tape shall be manufactured by:

1. 3M – St Paul, MN;
2. Or approved equal.

F. Glass Tape shall be manufactured by:

1. 3M – St Paul, MN;
2. Or approved equal.

G. Pulling lubricant shall be as manufactured by:

1. American Polywater Corporation, Stillwater MN;
2. 3M – St. Paul, MN;
3. Ideal Industries, Sycamore, IL;
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Medium-Voltage Cable

1. Medium-voltage cable shall be rated for a 133% insulation level at the system nominal phase voltage. Cable insulation shall be lead free thermosetting ethylene propylene rubber based, suitable for normal installation, indoors or outdoors, in conduit, in air, in underground ducts and intermittent or continuous submersion in water. Medium-voltage cable shall consist of either single or multi-conductor cable bearing the UL "MV 105" label and comply with or exceed ICEA S-93-639 and AEIC CS8.
2. The size and quantity of medium-voltage cable shall be as indicated in the conduit and cable schedule. Medium-voltage cable shall be in accordance with the following:
   a. Conductors shall be soft annealed uncoated copper with concentric-lay Class B compact round stranding in accordance with the current ASTM Standard B 496.
   b. The cable insulation system shall be comprised of a conductor shield overlaid by the primary insulation overlaid by the insulation shield.
      1) The conductor shield shall consist of an extruded layer of non-conducting energy suppression or semiconducting material.
      2) The primary insulation shall be a high-quality ozone resistant lead-free ethylene-propylene rubber based compound. The insulation system shall be suitable for use at conductor temperatures not exceeding 105 degrees C for normal operation, 140 degrees C for emergency overload

conditions, and 250 degrees C for short circuit conditions. Minimum average thickness of the insulation system at any point of the cable shall not be less than 115 mils for 5 KV systems, 220 mils for 15 KV systems and 345 mils for 25 KV systems. The minimum thickness at any part of the cable shall not be less than 90 percent of the specified average.

3) The insulation shield shall be layer of semi-conducting material.

4) The metallic shield shall overlay the insulation shield and shall be a copper tape applied helically with a nominal 25 percent overlap. The minimum thickness of the copper tape shield shall be 5 mil.

c. A continuous jacket of moisture, heat, oil, sunlight, and UV resistant thermoset chlorinated polyethylene base compound shall be applied over the metallic shield. The average minimum thickness of the jacket at any point of the cable shall be in accordance with ICEA S-93-639.

B. Accessories

1. Cable connectors shall be provided for connecting medium-voltage cable. Connectors shall be in accordance with the following:

   a. Connectors shall be copper, tin-plated, long barrel compression type, UL listed. Suitable for voltage applications up to 35 KV.

   b. For sizes 250MCM and larger, connectors shall be two holes mount type with provisions for two (2) bolts for joining to apparatus terminal.

2. Cable terminators shall be provided for terminating medium-voltage cable. Terminations shall be in accordance with the following:

   a. Cable terminations shall meet Class 1 requirements and be design-proof tested per IEEE 48.

   b. Terminations shall be of the molded elastomer, wet-process porcelain, cold-shrink or heat-shrinkable types with grounding provisions for the cable shielding.

3. Cable splices shall be provided for splicing medium-voltage cable, splicing shall be in accordance with the following:

   a. Cable splices shall be made using standard splice kits which reinstate the cable's insulation and jacket and continue the metallic shielding through the entire cable joint.

b. Splices shall be of the premolded, conventional tape cold-shrink or heat-shrinkable type.

4. Fireproofing Tape shall be in accordance with the following:

a. Minimum thickness 30 mils

b. Resistant to water, salt water, acids, sewage, fungus, and UV light

c. Flexible unsupported elastomer

d. Intumescent and self-extinguishing

5. Glass Tape shall be in accordance with the following:

a. Minimum width 0.5 inch

b. Minimum temperature rating 450-degree F

c. Pressure sensitive

6. Medium-voltage cable pulling compound shall be used to reduce cable tension and side wall pressure and aid in minimizing damage during medium-voltage cable installation. Pulling lubricant shall be in accordance with the following:

a. UL Listed, compatible with the cable jacket, the raceway involved and acceptable to the cable manufacturer.

b. Pulling lubricant shall be water based, with a 0.17 average coefficient of friction and a temperature range of -20 to +120 degrees F.

c. Pulling lubricant shall confirm to IEEE 1210.

d. Pulling lubricant shall not support combustion.

e. Pulling lubricant shall not cause residue to cement jackets to the inside of conduit or ducts.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the medium-voltage cable at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ICEA and UL and shall demonstrate that the cable tested conforms to the requirements specified.

2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

3. All medium-voltage cables shall be shop tested in accordance with the following:

   a. Conductors shall meet the electrical resistance requirements of ICEA-S-93-639, Part 2.4.

   b. Insulation Resistance test shall be performed in accordance with the requirements of ICEA S-93-639, Part 4.3.2.5. Each cable shall have an insulation resistance not less than that corresponding to the insulation resistance constant of 20,000 megohms - 1000 ft. at 15.6 degrees C.

   c. A high voltage AC test shall be performed in accordance with the requirements of ICEA S-93-639, Part 4.0.

   d. Shield resistance shall be measured and recorded from end to end on the completed cable.

   e. Each reel of completed shielded power cable shall be partial discharge tested in accordance with ICEA S-93-639 Part 4.3.2.2.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with this Specification.

2. The Engineer shall have access during working hours for inspection purposes to all parts of the works where material and cable are being manufactured, and all reasonable inspection and testing facilities shall be provided to him without increase in price. The Engineer may request that dielectric strength tests and measurements be made to verify the cable data furnished by the Contractor. For this purpose, the Contractor shall furnish without increase in price, a length of cable, not to exceed three (3) feet for each size to be cut from one or more reels as directed by the Engineer. Each sample shall be marked with a tag bearing full description of cable insulation and number of reels from which it is cut.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All medium-voltage cables shall be installed within the raceways as shown on the Contract Drawings. They shall be carefully handled so as to avoid twists or kinks in the conductors or damage to the insulation.

B. The Contractor shall ensure that the manufacturer's recommended cable bending radii and pulling forces and corresponding tension in the cable are not exceeded and that the number of conductors permitted in a conduit are in accordance with the latest applicable requirements of the National Electrical Code.

C. No splices shall be permitted between terminals except at approved junction or terminal boxes. Boxes shall be provided as shown on the Contract Drawings or as required by Code for the pull lengths.

D. No more than two terminations shall be made at each terminal point.

E. Cable and wire runs shall be looped through pull boxes without cutting and splicing where possible.

F. All splices below grade, in manholes, hand holes and wet locations shall be waterproofed and fireproofed.

3.02 INSTALLATION

A. Cables

1. Medium-voltages cables shall be installed complete with proper terminations at both ends. For each circuit, Contractor shall ensure proper phasing and phase sequence.

2. Medium-voltage cables contained within a single conduit shall be pulled simultaneously using insulating pulling compounds containing no mineral oil.

3. Pulling tension on medium-voltage cables shall be continuously monitored using a calibrated Dynamometer type device, having a calibration label within six (6) months of its use.

4. Medium-voltage cables shall be installed with maximum slack at all terminal points, boxes, handholes and manholes.

5. Medium-voltage cables located within vaults, manholes, handholes and boxes shall be wrapped with fireproofing tape for their entire length on an individual cable basis. Medium-voltage cables shall be fireproofed in accordance with the cable manufacturer's recommendations and then covered with glass tape extending at least one inch into any duct.

B. Identification

1. Each cable and conductor shall be labeled at each termination point and all splice locations. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification stamped on terminal boards when provided or the cable so it is visible around the cable's circumference.

2. Each conductor shall be identified in junction boxes, cabinets, and terminal boxes. Where no termination is made, use a plastic-coated, self-adhesive, wire marker. Where termination is made, use a plastic, pre-printed sleeve wire marker. Paper, self-adhesive wire markers shall not be used.

3. In manholes and handholes, each cable shall be identified by a laminated plastic tag located so that it can be seen from center of manhole without

moving adjoining wires. Bundle and mark cables as listed in conduit and cable schedule.

4. Medium-voltage cables shall be color coded by a bright yellow colored tape band. Conductor identification shall be marked by a single wrap for Phase A, a double band for Phase B and three bands for Phase C.

3.03 FIELD TESTING / QUALITY CONTROL

A. The Contractor shall provide acceptance testing of the medium-voltage cable. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

1. Each medium-voltage cable circuit shall be acceptance tested on an individual per phase basis, all testing and inspection shall be performed by the testing firm.

2. Visual and mechanical inspection shall be performed for all splices and terminations.

3. Electrical tests shall be performed for each cable. Testing shall include the shield continuity test and the DC high potential test and shall be in accordance with the following:

a. The following procedures shall be adhered to before performing dc over potential tests:

1) All equipment transformers, switches, motors, circuit breakers, surge arrestors, etc. shall be disconnected from cable circuit to prevent test interruptions due to flashovers or trip outs resulting from excessive leakage current.

2) Adequate clearance shall be established between the circuit test ends and any grounded object and to other equipment not under test.

3) Circuit conductors not under test shall be grounded including all cables shields and nearby equipment.

4) Insulation surfaces shall be cleaned.

5) Cable ends shall be kept dry.

b. High-potential test shall be applied slowly in 8 to 10 equal steps to 80 percent of the NETA test value or manufacturer's shop production test value, whichever is smaller. Record the leakage current at each test voltage and plot the curve on graph paper.

c. The test shall be stopped, if the leakage current increases excessively or a "knee" appears in the curve before reaching maximum test voltage.

d. Upon reaching the specified maximum test voltage, the voltage shall be maintained for 15 minutes, record the leakage current at 30 seconds and one minute and at one-minute intervals thereafter. Plot leakage current versus time on the same graph as the step voltage curve.

e. Conductor test potential shall be reduced to zero and measure residual voltage at discrete intervals.

f. Grounds shall be applied to drain all insulation stored charge. Conductors shall be connected to ground through a suitable discharge resistor for one minute and then subsequently grounded directly.

g. New cable failing the test shall be replaced and retested.

h. The test curves shall be signed by the tester and initialed by the Engineer.

4. All tests and values for cable shall be in accordance with the manufacturer's recommendations and NETA, ATS Acceptance Testing Specification.

5. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA, ATS Acceptance Testing Specification.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing low-voltage electric wires, cables, and accessories.

1. Low-voltage electric wires, cables, and accessories shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. Low-voltage electric wires and cables to be provided shall include all accessories.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 – General Electrical Requirements

B. Section 26 05 27 – Grounding

C. Section 26 05 53 – Labelling and Identification.

D. Section 26 06 11 – Cable and Conduit Schedule

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

2. Low-voltage wires and cables shall mean all insulated electric wires and cables intended for use for power, lighting, control, instrumentation, communication, security, and alarm circuits.

3. Low-voltage wires and cable accessories shall mean all devices and items intended to provide mechanical protection, terminate, connect, splice, insulate, tag, and manage low-voltage wires and cables.

4. Cable is an assembly of insulated wires combined with fillers and separators in an enclosing jacket of insulating material.

5. All references to the Electric Utility or Utility shall mean Consolidated Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

Low-voltage wires and cables shall comply with the latest applicable provisions and recommendations of the following:

1. ANSI/ICEA S-95-658/

2. NEMA WC70 - Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.

3. ASTM B8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

4. ASTM D69 - Standard Test Methods for Friction Tape

5. ASTM D2301 - Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

6. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

7.	ICEA S-58-679	-	Standard for Control, Instrumentation, and Thermocouple Extension Conductor Identification.
8.	IEEE C2	-	National Electrical Safety Code.
9.	IEEE 1210	-	Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.
10.	NEMA WC 26/ EEMAC 201	-	Binational Wire and Cable Packing Standard
11.	NETA ATS	-	NETA Acceptance Testing Specifications.
12.	NFPA 72	-	National Fire Alarm Code
13.	NEC	-	National Electrical Code
14.	NYS Building Codes		- NYS Building Codes
15.	UL Standard No. 44	-	Thermoset-Insulated Wires and Cables.
16.	UL Standard No. 83	-	Thermoplastic-Insulated Wires and Cables.
17.	UL Standard 486A-486B		- Wire Connectors
18.	NYS BC	-	NYS Building Codes

C. Not Used

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. General:

1. All low-voltage wires, cables and accessories shall be made by an approved manufacturer, and in their construction shall be employed the most improved commercial materials and processes of manufacture.

2. Only low-voltage wires, cables and accessories manufactured under high standards of production and meeting the approval of the Engineer shall be used.

3. Friction tape shall be in accordance with ASTM. D69.

4. All low-voltage wire and cable splicing and terminations shall be done by experienced cable splicers who have worked with similar wire and cable for a period of at least five (5) years, using materials and procedures recommended by the wire and cable manufacturer. All splicing and terminations of low-voltage wire and cable shall be in accordance with the instructions of the low-voltage wire and cable manufacturer.

5. The low-voltage wire and cable manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration of testing apparatus shall be within one year.

6. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology and the NETA acceptance testing specification.

7. The mineral-insulated metal sheath cable installation shall be performed by experienced mineral-insulated metal sheath cable installers who shall have been regularly engaged in the installation of mineral-insulated metal sheath cable for a minimum of the past three years.

8. The Contractor shall retain the services of the mineral-insulated metal sheath cable manufacturer's representative to certify the cable installation is in accordance with the manufacturer's requirements.

9. Field testing of low-voltage wires and cables shall be in accordance with the requirements specified under this Section.

10. The Contractor shall perform acceptance testing on the low-voltage wire and cable installation.

    a. The Contractor shall have minimum of five years' experience in the inspection and testing of wires and cables of the type specified.

    b. The testing shall be performed in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers shall be submitted with the products they produce proposed for the contract.

2. Manufacturer's Literature, specifications and engineering data for low-voltage wires, cables and accessories including but not limited to:

    a. Manufacturer and type of wire or cable.

    b. Minimum insulation resistance in megaohms per 1,000 ft. at 20 degrees C.

    c. Material, number, and size of strands composing each conductor.

    d. Conductor insulation thickness in inches with material and voltage rating.

    e. Jacket thickness in inches.

    f. Average outside diameter of bare conductor.

g. Average outside diameter of finished wire or cable and jacket material.

h. Weight per 1,000 ft. of finished wire or cable.

i. Minimum bending radius, in inches.

j. Minimum pulling temperatures at which cable may be pulled without damage.

k. Maximum pulling tensions which may be applied to the cable without damage.

l. Literature identifying the methods and materials which Contractor proposes to use to make splices and terminations. Submittal shall consist of manufacturer's literature evidencing compatibility of the conductor insulation and jacket of the wire or cable with the splicing or terminating materials and methods which Contractor proposes to use.

m. Manufacturer recommended pulling lubricants.

n. Qualifications of splicing and termination personnel.

3. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least forty-five (45) days in advance prior to conformation of witness testing dates and actual testing.

4. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 45 days in advance to actual testing, five (5) recent references with phone numbers shall be submitted.

5. Qualifications of proposed mineral-insulated metal sheath cable installer shall be submitted. Submit installer experience records with five (5) recent completed installations with names and phone numbers.

6. Certification from the mineral-insulated metal sheath cable manufacturer's representative that the cable installation is in accordance with the manufacturer's requirements.

B. Reports:

1. Shop and field test reports shall be submitted.

2. Acceptance testing report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Low-voltage wires, and cables shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer's instructions.

B. Deliver low-voltage cables on factory reels conforming to NEMA WC26. Each end of each length of cable shall be hermetically sealed with the manufacturer's end caps and securely attached to the reel. Reels with unsealed ends will be rejected.

C. Inspect wire and cable protective coverings for evidence of damage during shipment.

D. Accomplish unloading without contacting cable surface or protective coverings or dropping cable reels from the delivering vehicle to the ground.

E. Store wires and cables on reels on elevated hard surfaces in a clean dry location away from construction equipment, falling objects, sources high heat and chemicals or petroleum products.

F. Seal cut cable ends using properly sized heat shrink cap to prevent moisture ingress and wicking into the cable interior.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Low-voltage single conductor wires for installation in conduit shall be as manufactured by:

1. Southwire, Carrollton, GA;
2. General Cable, Highland Heights, KY;
3. Okonite Company, New York, NY;
4. Or approved equal.

B. Low-voltage cable shall be as manufactured by:

1. Southwire, Carrollton, GA;
2. General Cable, Highland Heights, KY;
3. Belden; Indianapolis, IN
4. Okonite Company, New York, NY;
5. Or approved equal.

C. Compression connectors ring tongue type shall be manufactured by:

1. Ideal Industries, Sycamore, IL;

2. Thomas and Betts, Memphis, TN;
3. Burndy, Manchester, NH;
4. Or approved equal.

D. The mineral-insulated metal sheath cable shall be as manufactured by:
1. Pentair Pyrotenax, Houston, TX;
2. AFC Cable Systems, New Bedford, MA;
3. Or approved equal.

E. Compression splices shall be manufactured by:
1. Ideal Industries, Sycamore, IL;
2. Thomas and Betts, Memphis, TN;
3. Burndy, Manchester, NH;
4. Or approved equal.

F. Waterproof compression splices shall be manufactured by
1. Ideal Industries, Sycamore, IL;
2. Thomas and Betts, Memphis, TN;
3. Burndy, Manchester, NH;
4. Or approved equal.

G. Spring connector splices shall be manufactured by:
1. Ideal Industries, Sycamore, IL;
2. Thomas and Betts, Memphis, TN;
3. Burndy, Manchester, NH;
4. Or approved equal.

H. Markers shall be as manufactured by:
1. Ideal Industries, Sycamore, IL;
2. Thomas and Betts, Memphis, TN;
3. Brady, Milwaukee, WI;
4. Or approved equal.

I. Pulling lubricant shall be as manufactured by:
1. American Polywater Corporation, Stillwater MN;
2. 3M – St. Paul, MN;
3. Ideal Industries, Sycamore, IL;

4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Low-voltage Voltage wire and cable

1. Low-voltage wire and cable shall be used for all power, lighting, control instrumentation, alarm, and security system circuits. The size and quantity of low-voltage wires and cables shall be as indicated in the conduit and cable schedule. The conductor jacket shall be in accordance with color identification requirements specified under this Section.

2. Low-voltage single conductor wires for installation in conduit shall be in accordance with the following:

   a. Conductors shall be stranded, copper, single conductor wire conforming to ASTM B8, and B33 No. 12 AWG minimum size.

   b. Conductor insulation shall be flame-retardant, moisture and heat resistant thermoset rated 90 degrees C in dry locations and 75 degrees C in wet locations and listed by UL as type XHHW-2 or RHW.

   c. XHHW-2 shall be used for all indoor circuits and RHW for all underground and outdoor circuits.

3. Low-voltage cable for installation in conduit shall be in accordance with the following:

   a. Conductors shall be stranded, copper conforming to ASTM B8 and B33, No. 12 AWG minimum size.

   b. Conductor insulation shall be moisture and flame-resistant cross-linked polyethylene rated 90 degrees C in wet and dry locations and listed by UL as type XHHW-2.

   c. Cable conductors shall be assembled together with flame and moisture resistant filters and tape to make round.

   d. Cable shall include an overall protective jacket of polyethylene compound, 45 mils minimum thickness.

4. Instrumentation cable shall in addition comply with the following:

   a. Conductors shall be No. 16 AWG minimum size

   b. All conductors shall be polyethylene insulated and twisted in pairs with aluminum-mylar shield overlap.

   c. Cable jacket shall be low halogen.

5. Communication cable shall in addition comply with the following:

   a. Conductors shall be No. 24 AWG minimum size.

b. Conductor twist and shielding shall be provided..

c. Cable jacket shall be low halogen.

6. Fire Alarm cable shall in addition comply with the following:

a. Conductors shall be 18 AWG minimum size.

b. Cables shall be UL listed for the intended service.

c. Cables intended for use in the installation shall be approved for the intended use by the authority having jurisdiction.

7. Security system cable shall in addition comply with the following:

a. Conductors shall be No. 22, AWG minimum size.

b. Conductor twist and shielding shall be provided by Contractor.

c. Coaxial cable shall be provided by Contractor.

8. Mineral-insulated metal sheath cable shall be used for the fire pump circuits. The mineral-insulated metal sheath cable shall be in accordance with the following:

a. The mineral-insulated metal sheath cable shall be NEC, type MI. The cable assembly shall be UL listed including support for a 2-hour fire rating.

b. Conductors shall be solid copper conforming to ASTM B5.

c. Cable insulation shall be magnesium oxide mineral rated 600 volts, 90 degrees C. The cable shall include a metal-sheath consisting of seamless soft drawn copper.

d. The cable shall be provided with all fittings and hardware necessary for proper installation.

B. Low-voltage wire and cable accessories

1. Cable connectors shall be provided for terminating low-voltage wire and cable. Connectors shall be solder less type and properly sized to fit fastening device and wire size. Connectors shall be in accordance with the following:

a. For wire sizes up to and including No. 6 AWG, compression type with UL 486A listing shall be used. All cable terminations for conductors No. 10 AWG and smaller shall be terminated using UL listed ring tongue type, nylon insulated connectors, at each terminal board.

b. For wire sizes No. 4 AWG and above, either compression type or bolted type with tin-plated contact faces shall be used.

c. For wire sizes No. 250 kcmil and larger, connectors with at least 2 cable clamping elements or compression indents and provision for at least 2 bolts for joining to apparatus terminal shall be used.

2. Splicing for low-voltage wire and cable shall be performed when terminals are not provided. Splicing shall be in accordance with the following:

   a. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings with UL 486A listing. Splices shall be taped and covered with materials recommended by the cable manufacturers, to provide insulation equal to that on the conductors.

   b. For wire sizes No. 10 AWG and smaller, splices shall be made up with preinsulated, spring connectors. Connectors shall be flame retardant with UL listing. Spring connectors shall be Twister type.

   c. For wet locations, splices shall be waterproofed. Compression type splices shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductor. Waterproof compression splices shall be UL listed, heavy wall type. Spring connector splices shall be UL listed and waterproofed with a sealant-filler. Spring connectors shall be Twister DB type.

3. Compression connectors shall be ring tongue type.

4. Cable markers shall be provided for the identification of low-voltage wire and cable. Markers shall be in accordance with the following:

   a. Markers shall be vinyl type, moisture, heat, and abrasion resistant with adhesive back. Cable identification shall be clearly marked.

5. Low-voltage wire and cable pulling lubricant shall be used to reduce wire and cable tension and side wall pressure and aid in minimizing damage during low-voltage wire and cable installation. Pulling lubricant shall be in accordance with the following:

   a. UL Listed, compatible with the wire insulation or cable jacket, the raceway involved and acceptable to the wire and cable manufacturer. When wire and cable manufacturer shall be provided.

   b. Pulling lubricant shall be water based, with a 0.17 average coefficient of friction and a temperature range of 20 to 120 degrees F.

   c. Pulling lubricant shall confirm to IEEE 1210.

   d. Pulling lubricant shall not support combustion.

   e. Pulling lubricant shall not cause residue to cement insulation or jackets to the inside of conduit or ducts.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the low-voltage wire and cable at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of ICEA and UL and shall demonstrate that the wire and cable tested conforms to the requirements specified.

2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

3. All low-voltage wire and cable shall be shop tested in accordance with the requirements of this Specification.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with this Specification.

2. The Engineer shall have access during working hours for inspection purposes to all parts of the works where material and cable are being manufactured, and all reasonable inspection and testing facilities shall be provided to him without increase in price. The Engineer may request that dielectric strength tests and measurements be made to verify the cable data furnished by the Contractor. For this purpose, the Contractor shall furnish without increase in price, a length of cable, not to exceed 3 feet for each size to be cut from one or more reels as directed by the Engineer. Each sample shall be marked with a tag bearing full description of cable insulation and number of reels from which it is cut.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All low-voltage wires and cables shall be installed within the raceways as shown on the Contract Drawings. They shall be carefully handled so as to avoid twists or kinks in the conductors or damage to the insulation.

B. The Contractor shall ensure that the manufacturer's recommended cable bending radii and pulling are not exceeded and that the number of conductors permitted in a conduit are in accordance with the latest applicable section of the National Electrical Code.

C. No splices shall be permitted between terminals except at approved junction or terminal boxes. Boxes shall be provided as required by the Code for the pull lengths. No more than two (2) terminations shall be made at each terminal point. Cable and wire runs shall be looped through pull boxes without cutting and splicing

where possible. All splices below grade, in manholes, hand holes and wet locations shall be waterproofed.

D. No splicing of instrument wiring shall be permitted. Instrument wiring shall be extended by use of field termination boxes employing labeled terminal strips. Shield continuity shall be maintained. Ultimate shield termination (ground) shall be at one end only.

E. The mineral-insulated metal sheath cable manufacturer's representative shall review the cable installation to certify that the cables are installed in accordance with the manufacturer's requirements.

3.02 INSTALLATION

A. Wire and Cables

1. Cables shall be installed complete with proper terminations at both ends. For each motor circuit, Contractor shall ensure proper phasing, phase sequence and motor rotation.

2. Wire and cable contained within a single conduit shall be pulled simultaneously using insulating pulling compounds containing no mineral oil.

3. Pulling tension on wires and cables shall be continuously monitored using a calibrated Dynamometer type device, having a calibration label within six (6) months of its use.

4. Cables shall be installed with maximum slack at all terminal points, boxes, handholes and manholes.

5. Low-voltage cables located within manholes, handholes and boxes shall be wrapped with fireproofing tape for their entire length on an individual cable basis.

a. Tape shall be 30 mills thick of self-extinguishing material which will not support combustion.

b. Tape shall not deteriorate when subjected to water, salt, sewage, or fungus and shall be secured with glass cloth tape.

c. Low-voltage cables shall be fireproofed in accordance with the cable manufacturer's recommendations and then covered with tape extending at least one inch into any duct.

B. Conductor Identification

1. Each conductor shall be labeled at each termination point and all splice locations. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification stamped on terminal boards when provided or the cable so it is visible around the cable's circumference.

2. Each conductor shall be identified in junction boxes, cabinets, and terminal boxes. Where no termination is made, use a plastic-coated, self-adhesive, wire marker. Where termination is made, use a plastic, pre-printed sleeve wire marker. Paper, self-adhesive wire markers shall not be used.

3. In manholes and handholes, each power conductor shall be identified by a laminated plastic tag located so that it can be seen from center of manhole without moving adjoining wires. Bundle and mark control wires as listed in conduit and cable schedule.

4. Multi-conductor control cables shall be color coded in accordance with ICEA S-58-679, Method 1, Table E.

5. The following identification scheme shall be used for all low-voltage power circuits:

Voltage	Colors				
	Neutral Conductor	Phase A Conductor	Phase B Conductor	Phase C Conductor	Ground Conductor
208/120V	White	Black	Red	Light Blue	Green
240/120V	White-Gray Strip	Black-Blue Strip	RED-BLUE STRIP	None	Green
480/277V	Gray	Brown	Orange	Yellow	Green

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, all low-voltage wire and cable shall be field tested. The field tests shall be performed by the Contractor who shall furnish all testing equipment. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide a report identifying the tests performed and the results obtained.

B. Each electrical circuit shall be tested after permanent wires and cables are in place to demonstrate that the circuit and equipment are connected properly and will perform satisfactorily, as required, as intended, and that they are free from improper grounds and short circuits. The tests shall consist of the following:

1. Low-voltage wire and cable mechanical connections shall be individually tested after installation and before they are put in service with a calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.

2. Low-voltage wires and cables shall be individually tested for continuity between the required termination points for each ungrounded and grounded

conductor. Test wire and cable after installation and before first energization or before they are put in service with an approved continuity tester. Test results shall be as recommended by the wire and cable manufacturer or in accordance with NETA ATS, NEMA, ICEA Standards.

3. Low-voltage wires and cables shall be individually tested for insulation resistance between ungrounded and grounded conductors, and from each ungrounded and grounded conductor to ground. Test wire and cable after installation and before first energization or before they are put in service with an approved insulation resistance tester, for one minute at a voltage rating recommended by the cable manufacturer or in accordance with NETA ATS, NEMA, and ICEA Standards.

4. The insulation resistance for any given conductor shall not be less than the value recommended by the cable manufacturer or in accordance with NETA ATS, NEMA and ICEA Standards. Any cable not meeting the recommended value, or which fails when tested under full load conditions shall be replaced with a new cable for the full length.

5. Shielded instrumentation cable shields shall be tested with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground.

6. Connect Shielded instrumentation cables shall be connected to a calibrated 4-20 milliamp DC signal transmitter and receiver. Test at 4, 12, and 20 milliamp transmitter settings.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing grounding.

1. Grounding shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

2. The grounding work shall be a complete system for the electrical and instrumentation systems, structures, and equipment. The work shall include grounding of all electrical equipment, transformer neutrals, equipment enclosures, grounding electrodes, fences, and gates.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 14 – Medium -Voltage Cables and Accessories.

B. Section 26 05 20 – Low -Voltage Wires, Cables and Accessories.

C. Section 26 05 33 – Raceways and Boxes for Electrical Systems

D. Section 26 05 43 – Underground Ducts, Manholes and Raceways for Electrical Systems.

1.04 REFERENCES

A. Definitions

1. Grounding

a. Grounding and grounding system shall be used interchangeably in this Section to mean the means and methods by which all electrical and instrumentation systems are grounded for the purposes of attaining safety grounding, equalization of ground potential, reducing ground potential rises during fault events and the grounding of the ungrounded conductor as required by the NEC and Electric Utility Standards.

2. Electric Utility

a. All references to the Electric Utility shall mean the Consolidated Edison Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

1.	NEC	–	National Electrical Code.
2.	Electric Utility	-	Con Edison Standards and Guidelines.
3.	UL 467	-	Electrical Grounding and Bonding Equipment.
4.	Con Edison	-	Specification EO-2022- Specification for High Tension Service

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. The grounding system maximum resistance shall not exceed five (5) ohms under normally dry conditions. All structures and metal equipment containing electrical apparatus shall be connected to ground.

B. All grounding associated with the service feeders shall be in accordance with the requirements of the Electric Utility.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts for the grounding materials proposed for use.
3. Scaled Shop Drawings showing proposed routing and layout of the grounding system.

B. Field test report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The grounding equipment shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ground cable shall be as manufactured by:

1. Erico, Solon, OH;
2. Harger, Grayslake, IL
3. General Cable, KY;
4. Or approved equal.

B. Ground rods shall be as manufactured by:

1. Erico, Solon, OH;
2. Harger, Grayslake, IL
3. Blackburn/Thomas and Betts, MN;
4. Thompson Lightning Protection Inc, MN;
5. Or approved equal.

C. Bolted or compression grounding connectors shall be as manufactured by:

1. Burndy, Manchester, NH;

2. Harger, Grayslake, IL
3. Thomas and Betts, Memphis, TN;
4. Or approved equal.

D. Welded grounding connections shall be as manufactured by:
1. Cadwell, Solon OH;
2. Harger, Grayslake, IL
3. Or approved equal.

E. Ground Resistance Tester shall be as manufactured by:
1. Fluke, Everett, WA.
   a. Model 1625-2 GEO
2. Megger, Dallas, TX.
   a. Model DET 2/3
3. AEMC Instrument, Dover, NH.
   a. Model 6471
4. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Ground Cable
1. The ground cable shall be soft drawn bare stranded copper conforming to ASTM B8 and B189, No. 8 AWG minimum size.
2. The insulated cable for equipment grounding shall conform to the requirements of Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

B. Ground Rods
1. Ground rods shall be stainless steel, 1-inch diameter and ten (10) feet long.
2. Ground rods shall have a drive point at the lower ends. The upper end of each rod shall be equipped with bronze, clamp type connectors with not less than four (4) bolts.

C. Grounding Connectors.
1. Compression connectors shall be heavy duty copper. Bolted connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts, and washers.

2. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. A complete ground grid system shall be installed as shown on the Contract Drawings.

B. Ground cable shall be installed around perimeter of structures at a minimum of 2 feet-6-inches below grade.

C. Ground rods shall be installed 2 feet below grade, 2 feet from foundation walls and shall extend 10 feet vertically into the earth or horizontally not less than 36 inches below grade.

D. Test points shall be installed at locations and in accordance with the details shown on the Contract Drawings.

E. Equipment shall be connected in accordance with the details shown on the Contract Drawings. All steel column and underground connections shall be welded except for test points.

F. Metal casings or supporting frames of electrical equipment, such as medium-voltage primary and secondary substations, medium-voltage and low-voltage switchgears, transformers, panel boards, control panels, motor control centers, and individual motor controllers shall be grounded. The equipment shall be thoroughly grounded to the facility grounding system. All metal conduits leaving all electrical equipment shall be grounded. Grounding type fittings shall be installed on flexible conduits.

G. An insulated cable for equipment grounding shall be installed with the phase conductors within the conduit for the nominal 120 volt and higher power, lighting, and control circuits.

H. Grounding installation requirements shall be in accordance with the Con Edison Specification EO-2022 – Specification for High Tension Service.

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, the completed ground system shall be field tested for operation and conformance. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:

1. Resistance testing shall be made using approve Earth Ground Resistance Testers not less than 48 hours after rainfall.

a. Resistance values above five (5) ohms shall be brought to the Engineer's attention with remedial recommendations.

2. Grounded cables and metal parts shall be continuity tested. The conduit system shall be ground tested in accordance with the requirements of Section 26 05 33 – Raceway and Boxes for Electrical Systems.

B. The Contractor shall provide a Field Test Report, the report shall identify the testing performed and the results obtained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing supporting devices.

1. Supporting devices shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

2. The supporting devices shall be a complete system for the equipment.

3. The Work shall include providing all required support devices to properly mount and secure all equipment furnished under this Contract.

B. This Section also includes equipment anchorage and restraints suitable to meet the specified seismic requirements.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

Section 26 05 33 - Raceways and Boxes for Electrical Systems.

1.04 REFERENCES

A. Supporting devices shall comply with the latest applicable provisions and recommendations of the following:

1. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy, High-Strength, Low-Alloy with Improved Formability, and Ultra-High Strength.
2. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
3. NEC - National Electrical Code.
4. NYCCC - New York City Construction Code.
5. MFMA 103 - Guidelines for the Use of Metal Framing.
6. MFMA 4 - Metal Framing Standards Publication.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. General

1. All channels, fittings and hardware used in the supporting system shall be in accordance with MFMA 4 and MFA 103.
2. The design of the support system shall be the responsibility of the Contractor. The Contractor shall provide the proper sized rods, channels, fittings, brackets, and appurtenances necessary to adequately support the equipment.
3. The Contractor shall retain the services of a Licensed Engineer, registered in the State of New York, to prepare support details for equipment exceeding fifty (50) pounds in weight. The Engineer shall stamp the support system design details.

B. Seismic Requirements

1. Equipment assemblies such as primary and secondary unit substations, medium-voltage switchgear, transformers, motor control centers and panelboards shall be certified to meet seismic requirements of the New York City Building Code. Refer to the Structural Contract Drawings for site-specific design criteria.

2. The Contractor shall provide equipment anchorage details for all equipment certified to meet seismic requirements. The details shall be coordinated with the manufacturer's equipment mounting provisions.

3. Electric conduit shall include seismic restraints in accordance with the requirements of Section 26 05 33 – Raceways and Boxes for Electrical Systems.

4. The Contractor shall retain the services of a Licensed Engineer, registered in the State of New York, to prepare the seismic anchorage and restraint details. The Engineer shall stamp the seismic anchorage and restraint details.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for approval by the Engineer.

B. Submittals shall include, but not be limited to the following:

1. Manufacturer's catalog cuts for the supporting devices proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.

2. Scaled Shop drawings showing dimensions and locations of all items and clearance requirements.

3. Support design details and equipment seismic anchorage and restraint details stamped by a NYS Licensed Engineer as required.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The supporting devices shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Supporting devices shall be manufactured by:

1. B-Line, Highland, IL;

2. Thomas and Betts Kindorf, Memphis, TN;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Channels, Fittings and Brackets

1. The Contractor shall provide channels, fittings, brackets, and related hardware for mounting and supporting the electrical equipment. Anchor bolts, concrete inserts, and related hardware for proper support of equipment shall also be provided. All equipment necessary to meet the seismic requirements specified shall be provided.
2. Channels shall conform to ASTM A1011/A1011M. Channels shall have a minimum thickness of 12 gauge. The cross-sectional width dimension shall be 1-1/2-inch minimum. The depth shall be as required to satisfy load requirements.
3. Attachment holes, when required, shall be factory punched on hole centers approximately equal to the cross-sectional width and shall be 9/16-inch diameter.
4. Fittings and brackets shall have 9/16-inch diameter holes on centers identical to the channel or as required to align with the channel holes. Fittings and brackets shall have the same width as the channel and shall be 1/4-inch-thick minimum. Fittings and brackets shall mate properly with the channel.
5. All channels, fittings, brackets, and related hardware shall be steel and have an electro-plated zinc finish according to ASTM B633.
6. In corrosive and classified areas, channels, fittings, brackets, and related hardware shall be type 316 stainless steel or PVC coated.

B. Conduit Hangers, Supports and Inserts

1. The Contractor shall provide channels, rods, straps, anchors, and related hardware for support of the exposed electric conduit system.
2. The Contractor shall also provide anchor bolts, concrete inserts, and related hardware for proper support of equipment. All equipment necessary to meet the seismic requirements specified shall be provided.
3. Conduit hangers, supports and inserts shall be in accordance with Section 26 05 33 – Raceway and Boxes for Electrical Systems.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. All supporting devices shall be installed level, parallel and perpendicular to building walls and floors, such that the support system is installed in a neat and professional manner.

B. All holes in hung ceilings for support rods and other equipment shall be made adjacent to bars where possible, to facilitate removal of ceiling panels.

C. The channels, fittings and brackets shall be rigidly bolted together and braced to make a substantial supporting framework support system.

D. Where motor control centers, switchgear, primary and secondary unit substations and other electrical equipment is being installed on concrete pads, the Contractor shall furnish leveling channels, fasteners, and other incidentals required for complete fastening to concrete pad. The Contractor shall install the leveling channel in the concrete pads. Seismic certified equipment shall be anchored in accordance with the seismic anchorage details.

E. All equipment fastenings to steel columns, beams and trusses shall be by beam clamps. In lieu of beam clamps, equipment may be welded to steel structures, subject to Engineer's approval.

F. No holes shall be drilled in any steel columns, beams, and trusses, unless otherwise noted in the Structural Contract Drawings.

G. Hanger rod supports shall be installed such that threaded rod is parallel to building walls and perpendicular to floors.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing conduit system.

1. The conduit system shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

2. The conduit system required shall be provided with all rigid and flexible conduits, boxes, fittings, supports, hangers and inserts and other conduit accessories as required for the installation of the electric wire and cable.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 05 05 23.02 - Miscellaneous Metal Fastening.

B. Section 09 91 00 - Painting.

C. Section 26 05 27 - Grounding.

D. Section 26 05 53 - Identification for Electrical Systems.

E. Section 26 06 11 - Cable and Conduit Schedule.

F. Section 26 05 29 - Hangers and Supports for Electrical Systems.

G. Section 40 05 07 - Hangers and Supports for Process Piping.

1.04 REFERENCES

A. Definitions

1. Conduit System: Shall mean a complete installation comprising all rigid conduit and flexible connections, boxes, fittings, supports, hangers, inserts and other conduit accessories as required for the installation of electric wires and cables.

2. Conduit Accessories: Shall mean all fittings required to ensure a complete conduit system installation. Conduit accessories shall include, but is not limited to, expansion, deflection, seal and drain fittings, hubs, bushings, duct seal, tags, markers, thruwall seals and bushings.

B. References

1. Electric conduit system shall comply with the latest applicable provisions and recommendations of the following:

2. NEC - National Electrical Code.

3. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

4. UL 6 - Rigid Metal Electrical Conduit -Steel.

5. UL 50 - Standard for Enclosures for Electrical Equipment.

6. UL 360 - Standard for Liquid-Tight Flexible Metal Conduit.

7. UL 514A - Metallic Outlet Boxes.

8. UL 514B - Conduit, Tubing and Cable Fittings.

9. ANSI C80.1 - Electric Rigid Steel Conduit.

10.	ASTM D870	-	Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
11.	ASTM D1735	-	Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus.
12.	NEMA RN-1	-	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts for the conduit, boxes, fittings and supports proposed for use.
3. Construction details of conduit racks and other conduit support systems with seismic restraint details and calculations signed by a NYS Licensed Engineer.
4. Scaled Shop Drawings showing proposed routing of all conduits, inclusive of conduits embedded in structural concrete and conduits directly buried in earth.
5. Scaled Shop Drawings showing locations of pull and junction boxes and all penetrations in walls and floor slabs.
6. Field test report.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Electric conduit system shall be delivered, stored, and handled in accordance with the Specifications, the manufacturer's instructions and the following:

1. Conduit shall be delivered to the work in standard bundles having each length suitably marked with the manufacturer's name or trademark and bearing the label of the Underwriters' Laboratories, Incorporated inspection service.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Rigid steel conduit shall be as manufactured by:
   1. Allied Tube and Conduit Corporation, Philadelphia, PA;
   2. Wheatland Tube Company, Sharon, PA;
   3. Republic Conduit, Louisville, KY;
   4. Or approved equal.

B. PVC coated rigid steel conduit shall be as manufactured by:
   1. Robroy Industries, Gilmer, TX;
   2. OCAL by Thomas & Betts, Memphis, TN;
   3. Or approved equal.

C. Hangers, Supports and Inserts shall be as manufactured by:
   1. B-Line, Highland, IL;
   2. Kindorf, Harahan, LA;
   3. Or approved equal.

D. Flexible conduit shall be as manufactured by:
   1. Anaconda American Brass Company, Rolling Meadows, IL;
   2. Electric-Flex Company, Roselle, IL;
   3. Or approved equal.

E. Hazardous area flexible conduit shall be as manufactured by:
   1. Crouse Hinds Company, Syracuse, NY;
   2. Appleton Electric Company, Rosemont, IL;
   3. Or approved equal.

F. Unions in hazardous locations shall be as manufactured by:
   1. Crouse-Hinds Syracuse, NY;
   2. Or approved equal.

G. Unions in non-hazardous areas shall be as manufactured by:
   1. Thomas & Betts, Memphis, TN;
   2. Or approved equal.

H. Expansion and deflection fittings shall be as manufactured by:
   1. Crouse-Hinds, Syracuse, NY;
   2. Appleton Electric, Rosemont, IL;
   3. Or approved equal.

I. Sealing fittings shall be as manufactured by:
   1. Crouse-Hinds, Syracuse, NY;
   2. Appleton Electric, Rosemont, IL;
   3. Or approved equal.

J. Drain fittings shall be as manufactured by:
   1. Crouse-Hinds, Syracuse, NY;
   2. Appleton Electric, Rosemont, IL;
   3. Or approved equal.

K. Conduit hubs shall be as manufactured by:
   1. O-Z/Gedney Rosemont, IL;
   2. Thomas and Betts, Memphis, TN;
   3. Or approved equal.

L. Conduit bushings and locknuts shall be as manufactured by:
   1. O-Z/Gedney, Rosemont, IL;
   2. Thomas and Betts, Memphis, TN;
   3. Or approved equal.

M. Duct seal shall be as manufactured by:
   1. American Polywater Corp, Stillwater, MN;
   2. O-Z/Gedney, Rosemont, IL;
   3. Ideal Industries, Sycamore, IL;
   4. Or approved equal.

N. Thruwall seals shall be as manufactured by:
   1. O-Z/Gedney Rosemont, IL;
   2. Or approved equal.

O. Floor seals shall be as manufactured by:

1. O-Z/Gedney, Rosemont, IL.;
2. Or approved equal.

P. Sealing bushings shall be as manufactured by:

1. O-Z/Gedney, Rosemont, IL;
2. Or approved equal.

Q. Fire stop fittings shall be as manufactured by:

1. O-Z/Gedney, Rosemont, IL;
2. Or approved equal.

R. Thru-wall barriers shall be as manufactured by:

1. Crouse-Hinds, Syracuse, NY;
2. Or approved equal.

S. Conduit tags shall be as manufactured by:

1. Seton Nameplate Corporation, Branford, CT;
2. Or approved equal.

T. Conduit markers shall be as manufactured by:

1. Thomas and Betts, Memphis, TN;
2. Or approved equal.

U. Terminal blocks shall be as manufactured by:

1. Allen-Bradley Company, Milwaukee, WI;
2. General Electric Company, Fairfield, CT;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Rigid Steel Conduit

1. The Contractor shall provide rigid steel conduit. All steel conduits shall comply with the requirements of ANSI C80.1, and UL 6.
2. Both the inside and outside surfaces of the rigid steel conduit shall be protected against corrosion by a coating of zinc applied by the hot-dip galvanizing process.
3. Conduits, elbows, and couplings shall be rigid, heavy wall, mild steel, hot dip galvanized. Conduits, elbows, and couplings shall have a smooth interior with tapered threads and carefully reamed ends. Conduit size shall be 3/4-inch minimum and shall conform to UL 6.

4. Conduits, elbows, and couplings shall include a PVC coating for all areas. For conduits located indoors in dry, dusty areas the use of rigid steel conduit without PVC coating shall be permitted.

5. PVC coating of conduit shall be factory applied and shall include a smooth 2 mil thick urethane interior coating and 40 mil thick polyvinyl chloride exterior coating. PVC coated conduit shall conform to NEMA RN-1, ASTM D870, ASTM D1735 and UL 6. The exterior PVC coating color shall be gray and listed UL DYJC. The threads of conduits that have been cut in the field to size shall have the same PVC coating applied.

B. Hangers, Supports and Inserts

1. The Contractor shall provide hangers, supports, and inserts for support of the electric conduit system. The supports shall securely attach the electric conduit system to the channel and structure.

2. The electric conduit system shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the New York State Building Code and the Uniform Building Code for Zone 2A application.

3. Transverse and longitudinal bracing shall be provided as required to brace the electric conduit for the seismic requirements specified.

4. All drilled in type concrete inserts shall be expansion shields or anchors conforming to Section 05 05 23.02 – Miscellaneous Metal Fastenings and 40 05 07 - Hangers and Supports for Process Piping. In corrosive and Class 1 and Division 1 locations, concrete inserts shall be 316 stainless steel.

5. Hangers and supports shall be in accordance with the requirements of Section 40 05 07 - Hangers and Supports for Process Piping except beam clamps, hanger rods and hardware shall be steel with electro-plated zinc finish. This shall also include bolts, nuts, and washers. In corrosive locations, hangers and support hardware shall be type 316 stainless steel or factory applied 40 mil thick PVC coated.

C. Flexible Metallic Conduit

1. The Contractor shall provide flexible metallic conduit where required to permit movement of connected devices and where it is impracticable to complete runs with rigid conduit subject to the limitations imposed by the NEC.

2. Flexible conduit used indoor in non-hazardous dry dusty areas shall be non-liquid-tight, with a steel core.

3. Flexible conduit used outdoors and in non-hazardous, wet, and corrosive areas shall be UL Listed and include a hot dipped galvanized steel core with

a liquid-tight, polyvinyl chloride cover and shall include a built-in copper ground for sizes 3/4-inch through 1-1/4 inch.

4. For hazardous areas flexible conduit shall include a brass inner core with a bronze outer braid and protective neoprene plastic coating. End fittings shall be steel, brass or bronze.

D. Outlet Boxes and Fittings

1. The Contractor shall provide outlet boxes and fittings for rigid and flexible conduit. The outlet boxes and fittings required for the work which constitutes a part of the conduit system, shall be of approved types.

2. Fittings, bodies, and boxes installed on PVC coated conduits shall have interior and exterior PVC coatings equivalent and corresponding to that of the conduit on which they are installed.

3. For outdoor, wet, and corrosive areas, conduit fittings and outlet bodies shall be cast gray iron alloy, cast malleable iron bodies, and covers. All units shall be gasketed, watertight, and threaded with five (5) full threads and shall have rustproofing in accordance with the requirements of this Section.

4. Threaded cast ferrous metal, hub type outlet boxes shall be used throughout, except in the interior walls of superstructures and in roof slabs protected by built-up roofing where pressed steel boxes shall be installed. Cast iron or alloy outlet boxes of the proper size and depths for the application, complete with watertight gaskets and covers secured by brass screws, shall be furnished, and installed as required by the conduit run. Outlet boxes, furnished and installed for the installation of lighting fixtures, switches and receptacles in a future contract, shall be furnished with watertight gaskets and blank covers.

5. For non-hazardous, indoor dry dusty areas pressed steel boxes of the proper size and depths for the application shall be provided. Boxes shall be rated NEMA 12, not less than No. 14 U.S. Standard Gauge (0.078 inch). The conduit openings shall be provided with oil-resistant gaskets. Conduits shall be fastened to these boxes with locknuts and bushings, and all unused outlets or holes shall be left sealed.

6. All outlet boxes intended for the support of fixtures shall be provided with approved fixture studs.

7. For concealed conduit runs in outside walls and all exposed conduit work, connections to boxes and fittings shall be made through threaded holes, unless otherwise approved by the Engineer. For concealed conduit work in non-hazardous areas in other than outside walls, connections between conduit and boxes may be made with drilled holes, using locknuts and bushings.

8. Where necessary unions may be used.
   a. In non-hazardous locations unions shall be universal or Erickson
   b. In hazardous locations unions shall be type UNF, UNL or UNY.
9. All boxes installed for concealed conduit, shall be provided with extension rings or plaster rings, and covers as required. For non-hazardous, dry indoor areas stainless 302/304, satin beveled steel cover and device plates for surface mounted boxes shall be used. For corrosive locations, galvanized ferrous and galvanized cast ferrous metal cover and device plates with neoprene gaskets shall be used.
10. Outlet boxes and fittings installed on PVC coated conduit shall also include interior and exterior coatings equivalent to the conduit.

E. Conduit Accessories

1. The Contractor shall provide conduit accessories for use with the conduit system. The conduit accessories shall be of approved types.
2. Expansion and Deflection Fittings:
   a. Expansion and deflection fittings shall be made up of non-corrodible parts and shall provide for ample longitudinal and lateral movement. A suitable bond shall provide a low resistance, continuous longitudinal path for ground currents.
   b. Expansion and deflection fittings shall be watertight cast iron, malleable iron or hot dipped galvanized. Fittings shall be corrosion-resistant, UL listed and compatible with the conduit system.
   c. Expansion /deflection fittings shall provide both expansion and deflection in a single fitting in accordance with the following:
      1) Axial expansion or contraction up to 3/4-inch.
      2) Angular misalignment up to 30 degrees.
      3) Parallel misalignment up to 3/4-inch.
      4) Expansion fittings shall provide expansion /contraction with eight-inch total movement.
3. Sealing Fittings:
   a. Sealing fittings shall be cast gray iron alloy or cast malleable iron or copper free aluminum with zinc electroplate and lacquer or enamel finish.
   b. Sealing fittings shall have an ample opening with threaded closure for access to conduit hub for making dam. Sealing fiber and compound shall be suitable for use with the fitting and shall be the products of the fitting manufacturer.

c. For corrosive locations, seal fittings shall include interior and exterior coatings equivalent to the PVC conduit coating specified under this Section.

4. Drain Fittings:

a. Drain fittings shall be a combination device designed to provide ventilation to minimize condensation and drains accumulated condensate.

b. The combination drain/breather fitting shall be 3/8-inch male thread size with stainless steel body.

5. Conduit Hubs:

a. Conduit hubs shall be threaded, insulated throat type with bonding screw locknut.

b. The conduit hub and locknut shall be malleable iron or zinc and shall include a 90-degrees C insulating surface and a sealing ring for a watertight and dust tight connection.

6. Conduit Bushings:

a. Conduit bushings shall be insulated, grounding type with lay-in-lug connection. Two (2) locknuts shall be provided for each bushing.

b. The conduit bushing and locknuts shall be steel, malleable iron or zinc. The bushing shall include a 90 degrees C insulating surface.

7. Duct Seal:

a. Duct seal shall be a suitable for forming a water and gas tight seal between cables and conduits.

b. Completed seal shall be resistant to gasoline, oils, dilute acids, and bases.

c. The completed seal shall be capable of blocking water pressure of at least 10 psi.

8. Thruwall Seals and Bushings:

a. New Construction

1) WSK and WSCS type thruwall seals shall be used for conduits and cables passing through exterior subsurface walls and exterior concrete walls.

2) CSMI type seal bushings at the inside and CSMC type seal bushings at the outside of the structure in the same core bit-drilled hole shall be used for conduits passing through interior concrete wall, interior floors, interior block walls,

exterior block walls, exterior subsurface walls, exterior concrete walls, floor slabs.

3) CFS and or CFSI type fire stop fittings shall be used for conduits passing through fire rated floors and walls.

4) TW type thru wall type barriers shall be use for multiple conduit runs passing through interior or exterior and fire rated walls.

b. Existing Construction

1) SK and FSCS type seals shall be used for conduits and cables passing through concrete floors and floor slabs.

2) CSMI type seal bushings at the inside and CSMC type seal bushings at the outside of the structure in the same core bit-drilled hole shall be used for conduits passing through interior concrete wall, interior floors, interior block walls, exterior block walls, exterior subsurface walls, exterior concrete walls, floor slabs.

3) CFS and or CFSI type fire stop fittings shall be used for conduits passing through fire rated floors and walls.

4) TW type thru wall type barriers shall be use for multiple conduit runs passing through interior or exterior and fire rated walls.

9. Conduit Tags:

a. Conduit tags shall be 19 gauge, 1-1/2-inch diameter round brass which shall be secured to the conduit with annealed brass wire.

b. Conduit tags shall be clearly stamped with the conduit number in conformity with the conduit and cable schedule or as directed by the Engineer.

10. Conduit Markers:

a. Conduit identification markers shall be self-sticking color-coded tape. Identification tape shall be two (2) inches wide and colored in accordance with the color banding specified under this Section.

F. Terminal, Junction and Pull Boxes.

1. The Contractor shall provide terminal, junction and pull boxes as shown on the Contract Drawings and where required by the NEC, or as directed by the Engineer.

2. Boxes located indoor in dry, dusty areas shall be NEMA Type 12, constructed of welded and galvanized sheet steel. Boxes of dimensions 24 inches and less shall be 14 USS standard gauge metal. Boxes of dimensions

greater than 24 shall be 12 USS standard gauge metal, except 10 USS standard gauge shall be used for boxes with any dimension of 36 inches or more. Boxes located in other areas shall conform to the following area classifications:

a. For wet locations boxes shall be watertight NEMA Type 4. Boxes shall be constructed of galvanized cast iron and shall include gasketed, bolt on covers, with tapped holes in bosses or hubs for conduit entrance. Boxes shall be provided with cast mounting lugs for installation in concrete.

b. For hazardous locations boxes shall be explosion proof NEMA Type 7. Boxes shall be constructed of cast iron and shall include threaded connections and ground joint surfaces.

c. For corrosive locations boxes shall be corrosion resistant, NEMA Type 4X. Boxes shall be constructed of 316 stainless steel material with sealed seams.

3. Pull and junction boxes shall be provided with covers held in place by brass screws. Terminal boxes shall be provided with terminal block supports and approved hinged covers fitted tightly against a gasket and secured by lug bolts and wing nuts. Hinges, lug bolts, wing nuts and other fittings shall be made of an approved, non-ferrous, non-corrodible metal. All boxes shall be provided with rabbeted gaskets or flange gaskets securely held in place.

4. Tapping for threaded connections to outlet boxes, junction boxes, pull boxes and conduit fittings in non-explosion proof construction shall conform to the following:

a. All threads shall be tapered.

b. If threads for connection of conduit are tapped all the way through a hole in an enclosure, or if an equivalent construction is employed, there shall be not less than 3-1/2 threads in the metal and the construction of the enclosure shall be such that a suitable conduit bushing can be properly attached.

c. If threads for connections of conduit are not all the way through a hole in a box wall, conduit hub or the like, there shall be not less than five full threads in the metal and there shall be a smooth, well rounded inlet hole for the conductors, which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing and which shall have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit. The threaded hole shall be provided with a conduit end stop.

d. Tapping for threaded connections for explosion proof construction shall conform to the requirements of the NEC for construction in Class I, Division 1, and hazardous locations.

5. Cast iron or cast ferrous alloy outlet boxes, junction boxes, pull boxes, conduit fittings and conduit accessories such as box covers shall be rust-proofed by zinc coating applied by the "hot-dip" process or shall be given a rust protective coating applied by either of the following methods:

   a. Method A:

      1) Castings shall be given a mechanical and chemical cleaning.

      2) Castings shall be given a phosphoric acid type dip.

      3) Then a coating of zinc chromate primer shall be applied.

      4) A coating of baked enamel finish shall be applied over the outside and inside surfaces of the castings.

   b. Method B:

      1) Castings shall be given a mechanical and chemical cleaning.

      2) Then a coating of cadmium shall be deposited electrolytically.

      3) Then a coating of zinc shall be applied by electroplating.

      4) Then a vinyl resin base aluminum lacquer shall be applied.

6. Stamped steel outlet boxes, junction boxes and box covers shall be rust-proofed by a zinc coating applied by an electro-galvanizing or sherardizing process. Fabricated sheet steel boxes shall be formed from galvanized sheet steel. Welded joints shall be touched up with aluminum lacquer and boxes and covers shall be given a shop priming coat of zinc chromate rust inhibiting paint.

7. Terminal blocks shall be used within terminal boxes for termination of prepared conductors No. 10 AWG and smaller. Terminal blocks shall be in accordance with the following:

   a. Terminal blocks shall be high density, screw terminal type suitable for rail mounting with quantities sufficient for the conductors to be terminated plus 20 percent spares.

   b. Terminal blocks shall be NEMA rated, 600 volts, 35 amperes suitable for 85 degrees C.

   c. Terminal block components shall have stainless steel and tin-plated copper alloy components, backed out captive screws and marking surface.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All conduits shall be installed in accordance with the requirements specified under this Section and in conformity with the sizes stated in the Specifications or shown on the Contract Drawings. They shall be installed complete with all accessories, fittings, and boxes, in an approved and workmanlike manner so as to provide proper raceways for electrical conductors.

B. The Contractor's attention is called to the fact that all conduit runs indicated on the Contract Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits to avoid interference. Where conduit runs are not shown, it shall be the responsibility of the Contractor to establish the runs required based upon the various systems shown on the Contract Drawings.

C. Should any structural difficulties prevent the setting of cabinets, boxes, conduits, etc., at points shown on the plans, deviations therefrom as determined by the Engineer will be permitted and shall be made without additional cost.

D. All exposed steel conduits, fittings, boxes, straps, racks, and hangers shall be painted in conformity with Section 09 91 00 - Painting. PVC coated conduit systems shall not be painted. Paint shall match the gray color of the PVC coated conduits.

E. Conduits shall be tagged using conduit tags. Conduit tags shall be installed where conduits terminate in equipment and enclosures.

F. Exposed conduits shall be color banded using conduit markers. Markers shall also include operating voltage when over 600 volts. Conduit markers shall be installed 360 degrees, double wrap around conduit exterior. Conduit markers shall be installed where conduits enter equipment, boxes, within each room, at wall penetrations and fifty (50) feet on centers in each area. When exposed conduits are to be painted, markers shall be installed after the conduits are painted. Color banding shall be in accordance with the following:

1. 120/208 volt AC: Gray.
2. 277/480 volt or 480 volt AC: Sand.
3. 4160 volt AC: Silver.
4. 13800 volt AC: Brown.

5. Fire Detection and Alarm: Red.
6. Telephone: Blue.
7. Intercommunication: Yellow.
8. Security System: Rust.
9. Low Voltage Switching, Instrumentation and Controls System: Black.

G. All enclosing cases, including condulets and conduit bodies, for fire, sprinkler, smoke detection, and associated systems alarm apparatus and equipment shall be painted or colored Fire Department "RED", in accordance with New York State Building Codes, unless otherwise required by the local Authority Having Jurisdiction (AHJ).

3.02 INSTALLATION

A. Installation of Raceways

1. The Contractor shall install all exposed raceways parallel or at right angles to walls and ceiling beams. Changes in directions shall be made with bends, elbows and pull boxes. All parallel runs shall be spaced uniformly throughout and secured in place with hangers and fasteners. Brace raceways to satisfy the specified seismic requirements in accordance with the restraint details.
2. Conduits, where exposed, shall in all cases be substantially supported in an approved manner, but they shall not be fastened to or come in contact with any other pipes, ducts or other work of a similar nature. In all exposed work, approved channel or angle iron hangers, racks, one-hole straps or a combination thereof shall be provided to support the conduits. Where conduits are supported with one-hole straps, spacers shall be used to provide 1/4-inch minimum clearance between the conduits and walls or ceilings.
3. Hanger rods for trapeze type hangers shall be not less than 5/8-inch diameter. Conduit supports shall be located at intervals not exceeding eight (8) feet. Conduits shall be securely fastened to each support with U-bolts, straps, or clamps.
4. All concealed conduits shall be placed in walls, floors, ceilings, or slabs at the proper time in accordance with the progress of the structural work. The Contractor shall cooperate in every respect in meeting schedules and shall not delay the structural work unnecessarily.
5. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during the pouring of concrete. The Contractor will be held responsible for proper position of conduits and shall rearrange any conduit that may be displaced while concrete is poured, without additional cost.

6. Where conduit runs are to be concealed and the Contractor fails to place such conduit in sufficient time to be included in the structures and the structures are completed without such conduit, the Contractor shall install such runs either concealed or exposed as directed by the Engineer, with no extra payment for additional work or for more conduit than the original lengths.

7. Embedded conduit shall be run in structural concrete in the center of slabs and walls and above waterstops. Conduit connections shall be made watertight. Contractor shall confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Embedded conduits shall be in accordance with the following criteria:

   a. Minimum concrete thickness shall be as follows:

      1) For concrete 16 inches thick and less, the minimum concrete thickness shall be 11.5 inches plus the depth of the largest conduit assembly. The conduit assembly depth shall be from the top of the uppermost conduit to the bottom of the lowest conduit.

      2) For concrete greater than 16 inches thick, the minimum concrete thickness shall be 13.5 inches plus the depth of the largest conduit assembly.

      3) For concrete at foundation slabs, an additional inch shall be added to the minimum concrete thicknesses previously stated.

   b. Conduit spacing shall be as follows:

      1) Conduits shall be separated three times outer diameter of larger conduit center to center.

      2) For multiple conduit layer assemblies, conduits shall be separated vertically three times outer diameter of larger conduit center to center.

      3) When conduits cross at a given point, the conduits may be in direct contact and the angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of a multi-conduit layer assembly.

      4) When conduits cross a structural expansion joint, conduits shall be separated three times outer diameter of larger conduit fitting center to center.

8. A run of conduit between outlet and outlet, between fitting and fitting or between outlet and fitting shall not contain more than the equivalent of

three-quarter (3/4) bends, including those bends located immediately at the outlet or fitting.

9. Factory-made conduit bends or elbows shall be used wherever possible in making necessary changes in direction. Field bends shall be carefully made so as to prevent conduit damage or reduction in the internal areas. The radius shall not be less than six times the nominal diameters for the conduit with carefully matched bends on parallel runs so as to present a neat appearance.

10. All conduits, where cut, shall be carefully reamed to remove burrs. No running threads will be permitted. All screw joints shall be watertight. Conduits shall be fitted in an approved manner to all devices and boxes. The ends of all conduits shall be equipped with suitable approved conduit fittings. The ends of all empty conduits shall stub up six inches above the slab and shall be capped.

11. As far as practicable, conduits shall be pitched to drain to outlet boxes or otherwise so installed as to avoid trapping moisture. Trapped conduits in concealed construction shall be provided with outlet boxes for drainage. Where necessary drainage in outlet boxes or where dips are unavoidable in exposed conduits, a drain fitting shall be installed at the low point.

12. Thruwall type seals and conduit sealing bushings shall be installed for all conduits passing through concrete slabs, floors, walls, or block walls.

13. Conduit runs shall be installed so as to avoid flues, heat sources, and steam or hot water pipes. A minimum separation of twelve (12) inches shall be maintained where conduit crosses or parallels hot water, steam pipes or heat sources.

14. Where conduit enter or leave equipment located within electrical and control rooms the conduit shall be sealed and packed with a suitable duct seal compound.

15. A 250-pound tested polyethylene pull tape shall be provided in all empty conduits, with a minimum eight (8) inch of slack, double backed into the conduit. Conduit shall be protected immediately after installation by installing flat non-corrosive metallic discs and steel bushings designed for this purpose at each end. Discs shall not be removed until it is necessary to clean the conduit.

16. All conduit that is cut on the job shall be cut square and taper reamed to remove burrs before installation. Where steel conduit is cut and threaded on the site, it shall be coated before and after making connections.

17. Conduits embedded in concrete shall stub up six (6) inches above the slab. A three-inch-high curb extending three inches from the outer surface of the conduit penetrating the floor shall be provided to prevent corrosion.

Conduit stub-ups shall be terminated in couplings, slightly above the finished concrete curb.

B. Conduit Connections to Equipment.

1. At each motor, limit switch, solenoid valve, electrical control device or other electrically controlled or operated equipment, the Contractor shall install a complete conduit connection between the conduit system and the terminal box of the motor or the conduit connection point of the equipment.
2. Conduits installed in the conduit system shall be terminated in such locations as to permit direct connections to motors, devices, or equipment.
3. Connections shall be made with rigid conduit if equipment is fixed and not subject to adjustment, mechanical movement, or vibration. Rigid connections shall be provided with union fittings to permit removal of equipment without cutting, breaking, or burning conduit.
4. Motors, transformers, and equipment subject to adjustment, mechanical movement or vibration shall be connected with flexible metallic conduit.
5. Devices such as solenoid valves, small limit switches, etc., shall be connected with flexible metallic conduit arranged to prevent strain and distortion.
6. Flexible conduit connections shall be watertight unless the area of installation requires explosion-proof construction.

C. Installation of Boxes and Fittings.

1. All concealed outlet boxes shall be set in such a manner that they will be plumb and flush with the finished surface.
2. Boxes shall be installed rigidly and securely to the structure. Independent supports shall be provided where no walls or other structural surface exists.
3. Expansion and expansion/deflection fittings shall be installed where conduits cross structural expansion joints and at locations required by the NEC. Fittings shall be installed on each conduit and incorporated into the expansion joints of structures, at right angles to the joint, to insure their proper functioning and preservation.
4. Expansion fittings shall be installed on exposed conduit runs exceeding two-hundred (200) feet. When crossing structural expansion joints larger than one inch, an expansion fitting shall also be installed together with an expansion/deflection fitting. The fittings shall be installed on each conduit run in accordance with manufacturer's recommendations to provide the additional movement necessary.
5. All conduit connections in wet and corrosive locations shall be made up watertight and shall terminate at enclosures with an approved conduit hubs.

6. All conduit connections in dry and dusty locations shall terminate at enclosures with bushings and lock nuts. Terminations shall include one bushing and two lock nuts at each location. Lock nuts shall be installed one inside and one lock nut outside the enclosure. All conduit shall be bonded to the safety ground.

7. At pull and junction boxes having any box dimension in excess of eighteen (18) inches, jumper type grounding bushings shall be installed on conduit ends and jumper wires shall be installed to bond all conduits and to bond conduits to boxes.

8. All insulated grounding bushings shall be bonded together and to the structure of the enclosure by a continuous, copper bonding wire.

9. Removable, flame-retardant, insulating cable supports shall be provided in all boxes with any dimension exceeding three (3) feet.

10. Scratched PVC coated boxes and fittings damaged as a result of installation work shall be touched up by field applying PVC coatings. All touch up work shall be in strict conformance with manufacturer's recommendations.

D. Installation within Hazardous Areas.

1. Explosion-proof boxes and fittings shall be of a type approved by the Engineer. Boxes and fittings shall be of cast iron with finish as specified hereinbefore or of an aluminum alloy specially developed for use in hazardous areas.

2. Explosion-proof boxes shall be suitable for the installation of explosion-proof switches, receptacles, lighting fixtures or other devices as indicated. All conduit connections to such boxes shall be made with threaded fittings. Bushings and locknut connections shall not be used.

3. Conduits terminating at explosion-proof boxes, enclosing circuit opening equipment, shall be sealed at the entrance to the box with an approved compound-filled sealing fitting to prevent passage of explosive or combustible gases through the conduit. Where construction prevents the use of sealing fittings, the ends of the conduits shall be properly sealed with sealing compound.

4. Sealing fittings shall be installed to seal each conduit leading from or entering into hazardous locations. Exposed conduits passing through hazardous locations shall be sealed at point of exit and entrance.

5. The installation of explosion-proof boxes, fittings and all conduits in connection therewith shall conform to the requirements of the NEC for Class I, Division 1 Group D hazardous location.

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, the electric conduit system shall be field tested. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:

1. Each conduit shall be tested by pulling through a cylindrical mandrel as specified under this Section. Maintain a record of all conduits testing clear.

2. Conduit systems shall be ground tested in the presence of the Engineer, who will inspect all enclosures, pull and junction boxes for bonding to the safety green conductor pulled with the nominal 120 volt and higher power and control circuits, and for bonding of the conduit grounding bushing to this safety ground.

3. The separation of above safety grounding system from the instrumentation signal grounding shall be verified.

4. The Contractor shall provide a Field Test Report. The Report shall identify the testing performed and the results obtained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. All conduits shall be carefully cleaned before and after installation and all inside surfaces shall be free from all imperfections likely to injure the cable. Conduits shall be cleaned in accordance with the following:

1. After erection of complete conduit runs, conduits shall be snaked with a suitable swab to which shall be attached an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit.

2. All conduits through which the mandrel will not pass shall be removed and replaced by the Contractor at their own expense.

3. After snaking, the ends of the dead-ended conduits shall be protected with standard malleable iron caps to prevent the entrance of water or other foreign matter.

4. Conduit ends shall be protected after cleaning with caps to prevent entrance of water, concrete, debris, or other foreign substance.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, furnish all materials and equipment required to provide cable tray systems complete with accessories as shown and specified under this Section, the Specifications, and the Contract Drawings.

B. This Section includes the requirements for ladder type cable trays and accessories.

C. Cable Tray installation shall also include the following:

1. Inserts and other electrical items which shall be installed embedded in concrete, or built into walls, partitions, ceilings, or panels constructed by the Contractor.

2. Installation procedures and schedules under other contracts shall be reviewed and coordinated with the Contractor regarding the installation of cable trays electrical items that must be installed.

3. Keep informed of the construction so the cable tray shall be installed within such time periods as will not delay the work of the Contractor.

4. Notify the Contractor in advance of the installation of the work included, so they shall have sufficient time for coordination and installation of interrelated items that are included in their contracts and that must be installed in conjunction with cable trays included under this Contract.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements.

B. Section 26 05 14 - Medium-Voltage Cables and Accessories.

C. Section 26 05 20 - Low-Voltage Wires, Cables and Accessories.

D. Section 26 05 27 - Grounding.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 33 - Raceways and Boxes for Electrical Systems.

G. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

H. Section 26 05 53 - Identification for Electrical Systems.

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

2. All references to the AHJ (Authority Having Jurisdiction) shall mean the NEC.

3. All references to the Electric Utility or Utility shall mean Consolidated Edison Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

1. ANSI/IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants.

2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron

			Alloy-Coated (Galvannealed) by the Hot Dip Process.
4.	ASTM A1011	–	Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability.
5.	ASTM A1008	–	Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, high-Strength Low-Alloy and high-Strength Low-Alloy with Improved Formability.
6.	ASTM B633	–	Specification for Electrodeposited Coatings of Zinc on Iron and Steel
7.	IEEE 1100	-	Recommended Practice for Powering and Grounding Electronic Equipment.
8.	NEMA VE1	-	Metal Cable Tray Systems.
9.	NEMA VE2	-	Cable Tray Installation Guidelines.
10.	NEC	-	National Electrical Code.
11.	NFPA 70B	-	Recommended Practice for Electrical Equipment Cable Tray Systems.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. All cable tray components and accessories shall be manufactured by a single company and shall be UL Listed and Labelled.

B. Manufacturers shall be firms regularly engaged in the manufacturer of cable trays and accessories of the types and capacities required for a minimum period of ten (10) years.

C. Cable tray systems and accessories shall be those products which have been in satisfactory service in situations similar to that proposed for this Contract for a period not less than five (5) years.

D. Cable trays and accessories shall comply with the manufacturer's recommendation and those of NEMA VE2 and the NEC.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to:

1. Manufacturer's catalog cuts and technical information required to demonstrate compliance with the specific requirements detailed in this Section and the Contract Drawings.
2. UL and NEMA Certifications
3. A complete materials list showing all items proposed for use.
4. Location of service facilities.
5. Construction details of cable trays showing:
    a. Materials of Construction
    b. Finishes
    c. Dimensions
    d. Accessories
    e. Layouts
    f. Supports
    g. Splices
    h. Installation details
    i. Loading capacities for supports.
6. Certificate of Compliance:
    a. Seismic qualification certification from the manufacturer including mounting recommendations.
7. Bill of Materials.

C. Reports:
1. Shop test and field test reports shall be submitted.
2. Manufacturer's site visit and acceptance testing reports shall be submitted.

D. Operation and Maintenance Manuals
1. Operation and Maintenance Manuals shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Cable trays and all associated accessories shall be delivered, stored, and handled in accordance with this Section, the Specifications, the manufacturer's instructions, recommendations, and the following:

B. Cable trays shall be delivered to the site in standard bundles having each length suitably marked with the manufacturer's name or trademark, and UL Label.

C. Cable trays and accessories shall be inspected for shipping damage when received.

D. Cable trays and accessories shall be handled in a manner to prevent damage to finished surfaces.

1. Maintain protective coverings until installation is complete.

E. Cable trays and accessories shall be stored indoors in original packing in clean, dry heated areas.

F. Evidence of water which may have entered packages during transit shall be checked.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Spare Parts

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for Cable Trays and accessories.

2. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

3. Spare parts for each Cable Tray type proposed for installation shall include at a minimum the following:

a. Two (2) of each unique and standard straight- section splice plate used per two-hundred (200) feet cable tray with a minimum of two (2) each.

B. Special Tools

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, special tools required to service and maintain the Cable Trays and accessories.

2. The tools shall be listed in an index and packed in containers suitable for active use around the site, bearing labels clearly designating the manufacturer's part number with complete information for use and care and storage.

3. Tools for each motor control center shall be included.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cable trays and accessories shall be as manufactured by:

1. Cooper B-Line, Highland, IL;

2. MP Husky, Simpsonville, SC;

3. Cope, Harvey, IL;

4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Materials and Finish

1. Aluminum Trays

a. Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063.

b. All fabricated parts shall be made from Aluminum Association Alloy 5052.

2. Pre-galvanized Steel Trays

a. Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.

3. Hot-Dip Galvanized Steel Trays

a. Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of

1) ASTM A1011 SS, Grade 33 for 14 gauge and heavier and shall be hot-dip galvanized after fabrication in accordance with ASTM A123.

2) ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter and shall be hot-dip galvanized after fabrication in accordance with ASTM A123.

b. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.

c. All hot-dip galvanized after fabrication steel cable trays must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc.

1) Failure to do so can cause damage to cables and/or injury to installers.

4. Stainless Steel Trays

a. Straight section and fitting side rails and rungs shall be made of Type 304 or Type 316 stainless steel.

b. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

B. Splice Plates

1. Aluminum Cable Tray

a. Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts.

b. Hardware shall be zinc plated in accordance with ASTM B633, SC1.

c. If aluminum cable tray is to be used outdoors, then hardware shall be Type 316 stainless.

2. Steel Cable Tray (including Pre-galvanized and Hot dip galvanized)

a. Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1.

b. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts.

c. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Ladder Type Cable Trays

1. Ladder type trays shall consist of two (2) longitudinal members (side rails) with transverse members (rungs) welded to the side rails.

2. Rungs shall be spaced six (6) inches on center.

3. Spacing in radiused fittings shall be nine (9) inches and measured at the center of the tray's width.

4. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges.

5. No portion of the rungs shall protrude below the bottom plane of the side rails.

6. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 when supported as a simple span, when tested in accordance with NEMA VE-1.

7. The cable tray shall be capable of supporting a 200-pound concentrated load at mid-point of span and centerline on tray when tested in accordance with NEMA VE-1.

8. Tray Sizes shall have 4-inch minimum usable load depth, or as noted on the Contract Drawing.

9. Straight tray sections shall have side rails fabricated as C-Sections.

10. All straight sections shall be supplied in standard 12-foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on the Contract Drawings.

11. Tray widths shall be eighteen (18) inches.

12. All fittings must have a three-inch tangent and a minimum radius of 12 inches.

13. Splice Plates

    a. Splice plates shall be the bolted type conforming to the following:

        1) The resistance of fixed splice connections between adjacent sections of tray shall not exceed 0.00033 ohms.

        2) Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.

14. Barrier Strips shall be placed and be fastened into the tray with self-drilling screws.

15. Accessories:

    a. All special accessories shall be furnished as required to protect, support, and install a cable tray system.

    b. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, especially designed ladder dropouts, barriers, etc.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Cable Tray

1. Install cable trays according to NEMA VE 2.

2. Installers must be certified and trained by manufacturer or manufacturer's representative.

3. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

4. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

5. Remove burrs and sharp edges from cable trays.
6. Join aluminum cable tray with splice plates; use rib-neck carriage bolts and locknuts.
7. Supports:
    a. Fasten cable tray supports to building structure and install seismic restraints.
    b. Trapeze supports shall be constructed from 12-gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware.
    c. Cable trays installed adjacent to walls shall be supported on wall mounted brackets such as B409 as manufactured by Cooper B-Line, Inc. or Engineer approved equal.
    d. Trapeze hangers shall be supported by 1/2-inch (minimum) diameter rods.
    e. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lbs.
        1) Fasteners shall comply with seismic-restraint details according to Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.
    f. Place supports so that spans do not exceed maximum spans on schedules and provide clearances.
    g. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
    h. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer.
    i. Arrange supports in trapeze or wall-bracket form as required by application.
    j. Locate and install supports according to NEMA VE 2.
    k. Do not install more than one cable tray splice between supports.
    l. Support cable trays independent of equipment fittings.
    m. Do not carry weight of cable trays on equipment enclosures.
8. Make connections to equipment with flanged fittings fastened to cable trays and to equipment.
9. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2.
10. Space connectors and set gaps according to applicable standard.

11. Make changes in direction and elevation using manufacturer's recommended fittings.
12. Make cable tray connections using manufacturer's recommended fittings.
13. Seal penetrations through fire and smoke barriers.
14. Future Installations
    a. If cable trays are sized for future cables, specify provisions for penetrations with sleeves through fire-rated partitions or use repairable firestop-sealing material.
    b. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
    c. Install cable trays with enough workspace to permit access for installing cables.
15. Cables of cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 Volts shall not be run in the same cable tray run.
    a. Separation of different systems and insulation levels are permitted in the horizontal and vertical in separate cable tray runs.
16. Covers:
    a. Install permanent covers, on vertical tray runs as required by NEC, after installing cable.
    b. Install cover clamps according to NEMA VE 2.
    c. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
17. Install warning signs in visible locations on or near cable trays after cable tray installation.

B. Grounding
1. Ground cable trays according to NEC unless additional grounding is specified.
2. Comply with the requirements in Section 26 05 27 – Grounding.
3. Cable trays section carrying electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
4. Verify that cable tray system is specified for grounding and bonding the largest power conductor in the tray.
5. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals.

6. The grounding conductor shall be sized according to NEC Article 250.122 - Size of Equipment Grounding Conductors, and Article 392 - Cable Trays.

7. Cable trays with powder-coat paint should have coating mask completely removed at factory supplied grounding location and spliced with listed connectors as recommended by manufacturer.

   a. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

8. Bond cable trays to power source for cables contained within with bonding conductors sized according to NEC Article 250.122 - Size of Equipment Grounding Conductors.

C. Cable Installation

1. Install cables only when each cable tray run has been completed and inspected.

2. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2.

3. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

4. Install cable ties with a tool that includes an automatic pressure-limiting device.

5. Fasten cables on vertical runs to cable trays every eighteen (18) inches.

6. Length of unsupported cable is dependent on the cable diameter.

7. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures.

8. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosures.

9. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

10. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

11. In existing construction, remove inactive or dead cables from cable trays.

12. Connect raceways to cable trays according to requirements in NEMA VE 2.

3.03 FIELD TESTING / QUALITY CONTROL

A. Tests and Inspections:

1. After installing cable trays and before electrical circuits are energized, survey for compliance with requirements.

a. Visually inspect cable insulation for damage.

b. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

c. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NEC.

d. Verify that communications or data-processing circuits are installed in separate cable trays.

e. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.

f. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

2. Visually inspect each cable tray joint and each ground connection for mechanical continuity.

3. Check bolted connections between sections for corrosion.

a. Clean and retorque in suspect areas.

4. Check for improperly sized or installed bonding jumpers.

5. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts.

a. When found, replace with specified hardware.

6. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays.

7. Test entire cable tray system for electrical continuity.

a. Maximum allowable resistance is one (1) ohm.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Remove protective coverings to cable trays as part of the final cleanup.

B. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction.

C. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

D. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

E. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing underground ducts, electric manholes and raceways for electrical systems.

1. This Section also includes requirements for providing electric handholes.

2. Underground ducts, electric manholes, electric handholes and raceways shall be provided in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

3. Underground ducts shall be concrete encased. The Contractor shall provide reinforced concrete encasement for the duct system.

B. The Contractor shall perform all excavations, complete all forms, and do backfilling and tamping, as required, as shown on the Contract Drawings or stated in the Sections.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 15 14 - Caulking, Waterproofing, and Pargeting

B. Section 03 21 00 - Reinforcing Steel

C. Section 03 30 00 - Cast-In-Place Concrete

D. Section 05 56 00.01- Miscellaneous Metal Castings

E. Section 26 05 27 - Grounding

F. Section 26 05 33 - Raceways and Boxes for Electrical Systems.

G. Section 31 23 16 - Excavation

H. Section 31 23 23 - Fill

1.04 REFERENCES

A. Definitions

1. All references to the Utility or Electric Utility shall refer Consolidated Edison Company of New York or the Local Electric Utility Having Jurisdiction.

B. Reference Standards

1. Underground ducts, electric manholes, handholes and raceways shall comply with the latest applicable provisions and recommendations of the following:

a. NEMA TC2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.

b. NESC - National Electrical Safety Code

c. NEC - National Electrical Code

d. UL 651 - UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

e. UL 2420 - UL Standard for Safety Below ground Reinforced Thermosetting Resin conduit (RTRC) and Fittings.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited, to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.

2. Manufacturer's technical information with name, designation and catalog number for all products for the underground ducts systems, manholes, handholes, raceways and accessories proposed for use.

3. Drawings showing interior and exterior dimensions and details of openings, jointing, inserts and reinforcing.

4. Scaled Shop Drawings showing the routing of the duct banks and the location of manholes, handholes and the principal outline of buildings and structures. Reference duct banks dimensionally from fixed objects or structures. Include profiles of duct banks showing crossings with piping and other underground systems.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Underground ducts, manhole, handholes and raceways shall be delivered, stored and handled in accordance with this Section, the Specifications and the manufacturer's instructions.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Rigid Steel Conduit: See Section 26 05 33 - Raceway and Boxes for Electrical Systems.

B. PVC conduit shall be as manufactured by:

1. Allied Tube & Conduit, Harvey, IL.

2. Heritage Plastics, Harvey, IL.
3. Or approved equal.

C. Fiberglass-reinforced epoxy conduit shall be as manufactured by:
1. FRE Composites Northeast, Boston, MA.
2. Champion Fiberglass, Spring, TX.
3. Or approved equal.

D. Warning tape shall be as manufactured by:
1. Seton, Branford, CT.
2. Ideal Industries, Sycamore, IL.
3. Or approved equal.

E. Duct Seal: See Section 26 05 33 - Raceway and Boxes for Electrical Systems.

F. Reinforced Concrete: See Section 03 30 00 - Cast-in-Place Concrete.

G. Expansion and Deflection Fittings: See Section 26 05 33 - Raceway and Boxes for Electrical Systems.

H. Conduit Bushings: See Section 26 05 33 - Raceway and Boxes for Electrical Systems.

2.02 MATERIALS / EQUIPMENT

A. Rigid Steel Conduit
1. Rigid Steel conduit without a PVC coating shall be used for all ducts from Utility service entrance point to the Medium Voltage Switchgear.
2. Rigid Steel conduit without a PVC coating shall be used for all Medium Voltage System throughout the underground system.
3. Rigid Steel conduit shall be used for all Instrumentation Systems and Communication Systems throughout the underground system.
4. Rigid Steel Conduit shall be in accordance with the requirements of Section 26 05 33 - Raceway and Boxes for Electrical Systems.

B. Non-Metallic Conduit and Fittings
1. Non-metallic conduit shall be used for all the underground power and control system except ducts from utility service to the medium voltage switchgear.
2. Non-metallic conduit for duct shall be PVC plastic or fiberglass-reinforced epoxy.

a. PVC plastic conduit shall be Schedule 40, NEMA type EPC-40 rated 90 degrees C, conforming to UL No. 651.

b. Reinforced thermosetting resin conduit and fittings shall conform to UL No. 2420. Both conduit and fittings shall consist of 68 percent glass content encapsulated in an epoxy matrix.

3. All non-metallic fittings, elbows, bodies, terminations, expansions and fasteners shall be the same material and manufacturer as the conduit.

C. Underground Duct Accessories and Fittings

1. Conduit Spacers

a. Factory fabricated conduit spacers shall be nonmetallic, vertical and horizontal interlocking type to maintain spacing between conduits. Spacers shall be suitable for all types of conduit in multiple sizes.

2. Warning Ribbon

a. Warning ribbon shall be a three inch wide, four mil polyethylene or polyvinyl chloride detectable tape. The tape shall be permanently imprinted in red color, "CAUTION BURIED ELECTRIC LINE BELOW."

3. Duct Seal

a. Duct seal for conduits shall be in accordance with the requirements of Section 26 05 33 - Raceway and Boxes for Electrical Systems.

4. Reinforced Concrete

a. Concrete for envelope shall be in accordance with the requirements of Section 03 30 00 - Cast-in-Place Concrete. Steel reinforcement shall be in accordance with the requirements of Section 03 21 00 - Reinforcing Steel. Ductbank shall be designed for HS-20 loading.

5. Expansion and Deflection Fittings

a. Expansion and deflection fittings shall be provided at the structural joints of the underground duct system.

b. Expansion and deflection fittings shall be in accordance with Section 26 05 33 - Raceway and Boxes for Electrical Systems.

6. Conduit Bushings

a. Conduit bushings shall be provided for the termination of rigid steel conduits at each manhole.

b. Conduit bushings shall be in accordance with Section 26 05 33 - Raceway and Boxes for Electrical Systems.

D. Manholes and Handholes

1. Manholes and handholes shall be cast-in-place type of reinforced concrete. The use of precast type manholes and handholes shall be permitted.

2. Manholes associated with service feeders shall be in accordance with the requirements of the Utility.

3. Concrete for manholes and handholes shall be in accordance with the requirements of Section 03 30 00 - Cast-in-Place Concrete. Manholes and handholes shall be constructed to withstand ground water pressure when completely submerged by rising water table. Manholes and handholes shall be designed to resist HS-20 loading, unless otherwise noted on the Contract Drawings.

4. Steel reinforcement shall be as shown on the details on the Contract Drawings and shall be in accordance with the requirements of Section 03 21 00 - Reinforcing Steel.

5. Manholes and handholes shall have dimensions as shown on the Contract Drawings and shall be provided with all duct entrances sized and located to suit duct banks.

6. Concrete floor shall be sloped towards the drain sump at the center of each manhole and handhole.

7. All manhole and handhole hardware shall be hot dipped galvanized steel.

8. All manholes related to Con Edison service shall be Type M11-6 and comply with Con Edison requirement.

E. Manhole and Handhole Accessories

1. Frames and Covers

a. Each manhole and handhole shall be provided with a cast-iron watertight manhole frame with inside and outside covers.

b. All frames and covers shall be in accordance with the requirements of Section 05 56 00.01 - Miscellaneous Metal Castings. Frames and covers shall be annealed, high quality, gray cast iron, free from blowholes, sandholes, scabs, fins, scales and other defects. They shall be uniform in form and dimensions, and shall be as approved by the Engineer.

c. The frames shall be so set that the completed installation will provide a proper alignment of the outside covers with the roadways or other surrounding areas. Manhole and handhole covers shall fit the frame without undue play.

d. The following words shall be cast in the top of all manhole and hand hole covers, as appropriate.

1) "ELECTRIC POWER, LOW VOLTAGE"

2) "ELECTRIC POWER, MEDIUM VOLTAGE"

3) "COMMUNICATIONS / INSTRUMENTATION"

e. Manholes and Handholes covers shall be designed to resist HS-20 loading, unless otherwise noted on the Contract Drawings.

f. All manholes cover and accessories related to Con Edison service shall be Type M11-6.

2. Cable Supports

a. Manholes shall be furnished with cable racks, cable hooks and insulators to effectively support all cables indicated for present and future installation.

1) Cable racks shall be made from steel channel with ample strength to support cables. Racks shall be firmly anchored to walls.

2) Cable hooks shall be made from malleable iron.

3) Racks and hooks shall have hot-dipped galvanized finish.

4) Insulators shall be made of high-grade dry-process porcelain with smooth glazed surfaces and shall fit hooks in such manner as to prevent wobbling and insure minimum movement.

3. Pulling Irons

a. Galvanized steel pulling irons shall be provided for each manhole and handhole. Pulling irons shall be cast in the wall opposite to the centerline of each incoming duct bank and twelve (12) inches below centerline of bottom line of ducts.

4. Grounding

a. Each manhole shall be provided with a grounding system. The grounding system shall consist of ground rods and cable in accordance with the details shown on the Contract Drawings.

b. Ground rods and cable shall be in accordance with the requirements of Section 26 05 27 - Grounding.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Duct Banks

1. The duct system shall be installed to avoid interferences with structures, piping and other underground systems. Conduit duct banks shall be sized, arranged and installed in a reinforced concrete envelope as shown on the Contract Drawings.

2. Trenches for duct banks shall be in accordance with the requirements of Section 31 23 15 - Excavation. Duct bank trenches shall have the bottom tamped firm and even, and suitably braced side forms shall be employed in forming the envelope.

3. Duct banks shall follow straight lines as far as possible. Where deviation from a straight line becomes necessary, offsets shall be made using 5 degree angle coupling or make bend with sweeps. The sweep radius shall be 48 inches for 90 and 45 degree bends and 36 inches for 30 degree bends. Bends shall be made up with standard factory bends or other approved curved sections.

4. Duct bank installations and penetrations through foundation walls shall be made watertight.

5. Duct banks shall be assembled using non-magnetic saddles, spacers and separators. Separators shall be positioned to provide 3-inch minimum concrete separation between the outer surfaces of the ducts.

6. Concrete covering shall be provided on both sides, top and bottom of the concrete envelopes around conduits. Concrete covering shall be in accordance with the detail shown on the Contract Drawings. Top of concrete encasement shall not be less than thirty inches below finish grade. Add red dye to concrete used for envelopes or trowel a coloring on the concrete for easy identification during subsequent excavation.

7. Before pouring concrete, written approval shall be obtained from the inspecting engineer.

8. Ducts shall be firmly fixed in place during pouring of concrete. Concrete shall be carefully spaded and vibrated to insure filling of all spaces between ducts.

9. A transition shall be made from non-metallic to rigid steel conduit where duct banks enter structures or turn upward for continuation above grade. Rigid steel ducts shall be terminated using insulated grounding bushings. Ducts inside buildings shall be continued using rigid steel or PVC coated rigid steel conduits as required for the area.

10. Ducts entering manholes and hand holes shall be terminated using suitable end bells. Rigid steel ducts shall be terminated using insulated grounding bushings.

11. Backfilling for duct banks shall be in accordance with the requirements of Section 31 23 25 - Fill. Backfilling shall be permitted when directed by the engineer to proceed. Backfilling shall not be with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.

12. Duct runs shall be sloped for drainage toward manholes and away from buildings with a slope of approximately three (3) inches per 100 feet.

13. A ground cable shall be installed in each duct bank envelope. Cable shall be in accordance with the requirements of Section 26 05 27 - Grounding. The ground shall be made electrically continuous throughout the entire duct bank system. Ground cable shall be connected to the building, station ground grid, equipment ground buses and to each conduit grounding bushing of the underground duct system. The ground cable shall be terminated at the last manhole or handhole for outlying structures.

14. A warning ribbon shall be installed approximately twelve (12) inches below finished grade over all underground duct banks carrying cables of 480 volts and higher.

15. All ducts entering buildings and structures shall be sealed. All empty spare ducts shall be sealed and plugged.

16. An expansion and deflection fitting shall be installed on each conduit at each of the structural expansion joints when shown on the Contract Drawings and the NEC requirements. Joints shall be located as defined by the criteria noted on the Contract Drawings.

B. Manholes and Handholes

1. Manholes and handholes shall be installed as shown on the Contract Drawings and the Con Edison requirements. Place each manhole and handhole on a 12 inch crushed-stone base and make level.

2. Manhole and handhole excavation shall be in accordance with the requirements of Section 31 25 15 - Excavation. Backfilling for manholes

and handholes shall be in accordance with the requirements of Section 31 23 23 - Fill.

3. Manhole and handhole installation shall be completed so that structure is watertight. All penetrations through manhole walls and bottoms to facilitate equipment such as ground rods shall be made through cast in place sleeves. Sleeves shall be made watertight after the installation of equipment. Two (2) coats of crystalline waterproofing material shall be applied to exterior surface of each manhole and handhole. A waterproof gasket shall be provided all around removable precast manhole cap in accordance with Section 03 15 14 – Caulking, Waterproofing, and Pargeting.

4. Cable racks shall be installed within each manhole for the support of cables. Cable racks shall be in accordance with the following:

   a. Attach racks with 3-inch by 3/8-inch diameter tamp-in studs mounted in 1-inch holes drilled into walls of manholes in the absence of inserts. Apply PVC coating to all racks.

   b. Provide cable hooks to support each cable on each rack along the cable run within the manholes. Apply PVC coating to all hooks.

   c. Individually support each cable at each hook on porcelain insulators. Provide sufficient slack for each cable.

   d. In the manhole securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape as manufactured by 3M or tie down with nylon straps.

5. A grounding system shall be installed for each manhole. All exposed metal, manhole frame and cover, accessories and the concrete reinforcing rods shall be bonded with No. 4 AWG minimum bare copper wire and connected to the duct bank ground in accordance with the details shown on the Contract Drawings.

6. Concrete curb shall be provided for manholes when required to adjust manhole cover to proper grade. Curb shall be constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the curb shall be such as is necessary to bring the manhole frame to the proper grade. Concrete curb shall be doweled into the manhole. The joint of the curb to the manhole shall remain watertight.

7. For cast in place type manholes and handholes, pulling irons shall be set and other built-in items shall be in place before placing concrete.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning and Protection

1. After installation each conduit in each duct bank shall be cleaned and cleared of obstructions and foreign matter by rodding and by the passage of cleaning brushes or cutting mandrels.

2. After cleaning, the clearance of each conduit shall be checked by passing a 12-inch-long mandrel, of diameter 1/2 inch less than the nominal duct diameter, through the entire length of duct run. Ducts which do not permit passage of the mandrel shall be cleared, cut out and replaced or sealed and replaced by additional construction. The duct bank conduit cleaning shall be included in the electric conduit system field test report specified in Section 26 05 33 - Raceways and Boxes for Electrical Systems.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place into satisfactory operation Vibration and Seismic Controls (V&SCs) for Electrical Systems complete with all auxiliary equipment as shown on the Contract Drawings and specified in the Specifications and this Section.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 26 05 11 – General Electrical Requirements.

C. Section 26 05 27 - Grounding

D. Section 26 05 53 – Identification for Electrical Systems

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volts and within the 600 V Class.

4. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 volts and below 99,000 volts.

B. Seismic Restraint as used in this Section and the Specifications shall mean a fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical and horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

C. VISCMA as used in this Section and the Specifications shall mean the Vibration Isolation and Seismic Control Manufacturers Association.

D. Reference Standards

1.	ASCE 7-16	-	Minimum Design Loads for Buildings and Other Structures
2.	FEMA 413	-	Installing Seismic Restraints for Electrical Equipment.
3.	MISR Guide	-	Mason Industries Seismic Restraint Guidelines.
4.	NYCBC 1613	-	NYCBC Section 1613 - Earthquake Loads
5.	NYSBC	-	New York State Building Codes.
6.	NEC	-	National Electrical Code.

1.05 DESCRIPTION

A. The Contractor shall provide fully functional vibration and seismic controls for equipment installed under Divisions 26.

B. The devices selected for vibration control or isolation for electrical system shall not transmit the vibrations to the building structure or foundations supporting building structure under normal operation.

C. The devices selected for seismic restraints or control should enable electrical equipment, conduits, components, etc. to resist seismic forces by the strength of their attachment to the building structure or move with the building structure and remain intact and functioning during and after an earthquake.

D. Equipment subject to requirement for vibration or seismic restraints includes but is not restricted to battery racks, bus ducts, cable trays, conduits, service entrance switchgears, switchboards, solar energy electrical power generation system, generators, transformers, unit substations, motor control centers, variable speed drives, resistive load banks, neutral grounding resistors and lighting fixtures.

E. Vibrations Control Devices (VCDs)

1. Provide vibration isolators, base frames and inertia bases of sufficient size and design to assure that deflection and stability requirements as specified in this Section are met.
2. Isolators shall be provided to deflect uniformly under operating loads.
3. Steel springs shall be selected to perform their function without undue stress or overloading as specified by the spring manufacturer.
4. All isolators shall have a minimum ¼" thick elastomeric or fiber glass acoustical pad within the vertical load path.
5. Stable steel springs shall be designed to operate in the linear portion of their load versus deflection curve and must be linear over a deflection range of not less than 50 percent above the specified deflection.
    a. The ratio of lateral to vertical stiffness shall be not less than 0.8.
    b. The designed deflection of each spring must be at least 75% of specified deflection of the spring.
6. Where detailed in this Section, the equipment Section with all structural steel bases supporting vibration isolated equipment, including concrete filled inertia bases, shall be designed, and fabricated by the vibration isolation manufacturer.
    a. All equipment mounted on vibration isolated bases shall have a minimum operating clearance of 2" between the base and floor or support beneath.

F. Seismic Control Devices (SCDs)

1. All seismic restraint devices shall meet the following minimum requirements:
    a. The snubber/restrained isolator for isolated equipment shall include a resilient element that will ensure that no un-cushioned shock can occur (excluding cable restraints).

b. It shall be possible to visually inspect the resilient snubbing material for damage and allow for replacement, if necessary.

c. All snubbers to include a maximum air gap of 0.25" (6mm).

d. Seismic restraint devices and systems shall be designed to offer seismic restraint in all directions.

e. Seismic restraint capacities shall be verified by one of the following methods at no additional cost to the City:

1) A Nationally Recognized Testing Laboratory (NRTL).

2) Certified by a registered Professional Engineer licensed in the State of New York.

3) By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.

2. Seismic restraint manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.

3. The Contractor shall furnish to the seismic restraint manufacturer a complete set of approved shop drawings of all equipment which is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed.

a. The shop drawings furnished shall include, at a minimum, basic equipment layout, length, and width dimensions, and installed operating weights of the equipment to be restrained.

4. All conduit, busway, and cable trays piping, and ductwork shall meet the requirement of NEC.

a. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as 'worst case' reaction loads for each restraint and/or anchor size.

5. The Contractor shall ensure that all housekeeping pads are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces.

a. In addition, the size of the housekeeping pad shall be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances exist to obtain desired equipment anchor capacities.

1.06 QUALITY ASSURANCE

A. The V&SC manufacturer shall be the manufacturer of all the major components of V&SC devices and assemblies.

B. Contractor must choose a manufacturer of the V&SCs who has produced V&SCs for a minimum period for the last fifteen (15) years.

1. The Contractor shall provide to DEP a list of at least five (5) installations with similar equipment, to that which will provided under this contract, and demonstrating compliance with these requirements.

2. The Contractor will provide the name, address, telephone number and e-mail of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning, and operation of the equipment at the above listed five (5) installations.

C. V&SCs shall comply with and be installed in accordance with New York State Building Codes.

D. V&SC devices shall have the manufacturers name, part number and material heat code stamped in the devices itself.

E. Independent testing agencies for V&SCs shall have fifteen (15) or more years conducting tests on V&SCs.

F. Calculations in relation V&SCs shall be made by a New York State Registered Professional Engineer and who has five (5) or more years' experience in providing vibration and seismic control calculations.

G. V&SC manufacturer shall be responsible for the selection of the attachment hardware as required to attach V&SC devices to both the equipment and supporting structure.

H. The requirements for V&SC in this Section are in addition to other requirements as specified elsewhere in the equipment Sections for the support and attachment of equipment and electrical services, and for the isolation of same equipment.

I. Nothing on the Contract Drawings or Sections shall be interpreted as justification to waive the requirements of this Section.

J. The Contractor shall furnish to the V&SC manufacturer a complete set of approved shop drawings of all equipment to which V&SCs are to be provided.

1. From these drawings the selection and design of devices and/or attachment hardware will be completed.

2. The shop drawings furnished shall include, at a minimum, basic equipment layout, length, and width dimensions, and installed operating weights of the equipment to which control systems or devices are to be applied.

K. Contractor shall coordinate with the V&SC manufacture the size of all housekeeping pads supporting equipment.

L. Contractor shall coordinate with V&SC manufacturer, equipment manufacturer and structural engineer to locate and size structural supports underneath equipment.

1.07 SUBMITTALS

A. Contractor shall submit shop drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Catalog cuts on all V&SC devices detailing compliance with this Section.
2. Detailed schedules of flexible and rigidly mounted equipment.
3. Fabrication details for all equipment bases including dimensions and structural member sizes stated on Contract Drawings, and support point locations.
4. All details of suspension and support for ceiling hung equipment.
5. Restraint and anchorage calculations for all V&SC devices.
6. Certified copy of the manufacturer's Design Tests made in accordance with and conducted on V&SC devices and type that is being offered for this Contract.
7. Certified dimensioned outline drawings showing equipment layouts, front and side views, and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available, and the interrelationship of the various components.
8. Cross sections and details, as required, to satisfy the Engineer, that all components conform to specification requirements, including design and physical arrangement.
9. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.
10. Weight of the equipment and reactions on the foundation support due to dead, live, and environmental loads.
11. Erection drawings.
12. Complete Bill of Materials.
13. Details of special features.
14. Nameplate schedules.

15. Recommended spare parts list with pricing.
16. List of Special Tools.
17. Painting Procedures.
18. List of recommended lubricants.
19. Preliminary Operation and Maintenance manuals.
20. Finalized Operation and Maintenance manuals.
21. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the manufacturer satisfies qualifications stated in this Section.
22. Reports.
    a. All shop test and field test reports.
    b. All manufacturer's Site visit reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. V&SC devices and systems shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

C. V&SC devices and systems shall be shipped and delivered in convenient shipping packages.
   1. Each package shall be mounted on shipping skids and wrapped for protection.
   2. Shipping package shall contain accessories to permit handling by cranes.

D. Contractor shall store the V&SC devices and systems and associated equipment in accordance with manufacturer's recommendations.
   1. Store all equipment in clean, dry space.
   2. Maintain factory protective wrappings or cover with heavy canvas or plastic to keep out dirt, water, and construction debris.
   3. Within twenty (24) hours of receiving the V&SCs the Contractor shall install temporary heaters to prevent condensation during storage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools and supplies with the V&SCs and associated equipment, neatly wrapped or boxed, indexed, and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

D. Furnish the following tools:

1. Two (2) sets of specialized wrenches and tools as required for proper installation, operation, and maintenance.

E. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance.

a. Replace all lubricants used during start-up and testing prior to acceptance of equipment.

b. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Vibration and Seismic Control Devices shall be as manufactured by:

1. Korfund Dynamics/The VMC Group, Bloomingdale, NJ
2. Mason Industries, Hauppauge, NY.
3. California Dynamics Corporation, Los Angeles, CA.
4. Vibration Eliminator Co. Inc., Copiague, NY.
5. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Vibration Control Devices (VCDs)

1. Type 1 (Elastomeric/ Fiber Glass Pads)

a. Elastomeric isolators shall be pads or molded configuration.

b. Pads shall be used in single and multiple layers.

1) Multiple layer pads shall comprise a bonded, galvanized sheet metal separation plate between each layer.

2) A load distribution plate shall be required to evenly distribute the load over the surface of the pad.

2. Type 2 (Elastomeric Mounts)

a. Elastomeric Isolator Mounts shall be molded from oil, ozone, and oxidant resistant compounds, designed to operate within the strain limits of the material.

b. Isolators shall include encapsulated load transfer plate for bolting to equipment and a base plate with anchor holes for bolting to the supporting structure.

3. Type 3 (Steel Spring Isolators)

a. Steel Spring Isolators shall be a freestanding and laterally stable spring assembly without a housing.

b. Isolators shall comprise a leveling device rigidly connected to the equipment or frame above.

4. Type 4 (Restrained Spring Isolators)

a. Spring Isolator shall be equipped with a restrained steel housing to prevent the equipment's operating height from changing should it be necessary to temporarily remove a portion of its weight.

1) The housing shall also function as rigid blocking during rigging so that the installed height and the operating height of the isolated equipment remains the same.

2) The isolator top shall have adequate means for fastening to the equipment, and baseplate shall have adequate means for fastening to the supporting structure, when the equipment is subject to wind loading.

5. Type H1 (Elastomeric Hanger)

a. Elastomeric Hangers shall comprise an elastomeric isolation element contained in a steel hanger housing.

b. The elastomeric element/hanger shall be shaped to prevent the rod from contacting the housing and thereby short-circuiting the isolation.

c. A steel load-distribution plate shall be incorporated/furnished sandwiching the elastomeric element to the hanger housing.

6. Type H2 (Spring Hanger)

a. Spring Hangers shall comprise a stable steel spring contained in a steel hanger housing with an integral elastomeric element to prevent metal to metal contact.

b. The bottom hole must be large enough to allow a +/- 15 degrees (30 degrees total) rod misalignment.

7. Type H3 (Combination Elastomeric/Spring Hanger)

a. Combination Elastomeric/Spring Hanger shall comprise a stable steel spring contained in a steel hanger housing.

b. An elastomeric element shall be added in series to isolate the upper connection of the hanger box to the structure.

c. The bottom hole must be large enough to allow a +/- 15 degrees (30 degrees total) rod misalignment.

8. Support Bases with VCDs

a. Type B (Structural Bases)

1) Structural Bases with integral isolators shall be engineered steel frames manufactured from structural steel shapes with welded height-saving brackets as required for side mounting of the isolators.

2) Frames may be square, rectangular, or T-shaped.

3) Adjustable motor slide bases shall be included when required for centrifugal fan applications.

b. Type C (Concrete Inertia Bases)

1) Concrete Inertial Bases shall be engineered steel forms with integrated isolator brackets.

2) Bases shall be shipped ready to be filled with concrete on Site by the Contractor.

3) Bases shall include welded or tied reinforcing bars running both ways in a single layer.

4) The bases shall include a template and fastening devices for the equipment for which it will be mated.

5) Weight of concrete and frame shall not be less than the weight of the equipment it supports.

6) Inertia bases shall be at least six (6) inches in depth.

7) Inertia bases shall be sized to accommodate the elbow support(s).

8) Adjustable motor slide bases shall be included when required for centrifugal fan applications.

c. Type D-1 (Curb Isolation Rails)

1) Vibration isolation curb elements shall be inserted between rooftop equipment and existing roof curbs.

2) Elements shall be of aluminum or steel construction and shall be attached to the equipment as specified by the curb isolation manufacturer.

3) Incorporated vibration isolators shall meet the specific characteristics described in this Section.

4) Elements exposed to the weather shall be galvanized or manufactured out of corrosion resistant materials.

5) Contractor shall be responsible for proper attachment of curb isolation elements to curbs.

6) Contractor shall be responsible for verifying the adequacy of the existing curb and its anchorage to the roof structure.

d. Type D-2 (Vibration Isolated Roof Curbs)

1) Curbs used to attach rooftop equipment to the structure shall be of aluminum or steel construction and shall be attached to the equipment as specified by the curb manufacturer.

2) Incorporated vibration isolators shall meet the specific characteristics described in this Section.

3) Elements exposed to the weather shall be galvanized or manufactured out of corrosion resistant materials.

4) Contractor shall be responsible for proper attachment of rooftop curb to building structure.

5) Contractor shall be responsible for coordinating the location of adequate structural support for the rooftop curb with the general contractor.

B. Seismic Control Devices (SCDs)

1. Type A (Coil Spring Isolator Incorporated Within a Cast Iron or Cast Aluminum Housing)

a. Cast iron or aluminum housings shall be made of ductile forms of the material designed for and rated in seismic restraint applications.

2. Type B, C and D (Coil Spring Isolator Incorporated Within a Steel Housing)

a. Spring isolators shall be seismically restrained, incorporating single or multiple coil spring elements, having all of the characteristics of free-standing coil spring isolators as specified in the vibration isolation portion of this Section.

b. Springs shall be restrained using a housing, without significantly degrading the vibration isolation capabilities of the spring during normal equipment operating conditions.

c. Vibration isolators shall incorporate a steel housing and resilient snubbing grommet system designed with clearances of no more than 0.25" (6 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed restraint housing.

1) In addition to the primary isolation coil spring, the isolator will include a resilient pad in series with the spring(s).

d. Spring elements shall be color coded or otherwise easily identified.

e. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be selected to provide a 50% overload capacity.

f. All springs shall be provided with a finish suitable for the application.

3. Type E (All-Directional Elastomeric Isolator)

a. Vibration Isolators shall be elastomeric, molded from oil, ozone, and oxidant resistant compounds, designed to operate within the strain limits of the isolator to provide the maximum isolation and longest life expectancy possible.

b. Isolators shall include an encapsulated load transfer plate for bolting to equipment and a base plate with anchor holes for bolting to the supporting structure.

c. Cast iron or aluminum housings shall be made of ductile forms of the material designed for and rated in seismic restraint applications.

d. Isolators shall have minimum operating static deflections as detailed in this Section and shall not exceed published load capacities.

4. Type F (All-Directional External Seismic Snubber Assembly).

a. Equipment shall be restrained against excessive movement during a seismic event by the use of all-directional resilient snubbers, designed to withstand the project-required seismic forces.

b. A minimum of three (3) snubbers shall be used for each equipment installation, oriented to properly restrain the isolated equipment in all directions.

c. Snubbers shall be of interlocking steel construction and shall be attached to the building structure and equipment in a manner consistent with anticipated design loads.

d. Snubbers shall limit equipment movement at each snubber location to a maximum of 0.25" (6 mm) in any direction.

e. Snubbers shall include a minimum 0.25" (6 mm) thick resilient pad to cushion any impact and to avoid any potential for metal-to-metal contact.

f. Snubbers shall be installed without significantly degrading the vibration isolation capabilities of the isolator during normal equipment operating conditions.

5. Type G (Lateral External Seismic Snubber Assembly)

a. Stable equipment (where uplift forces are zero or are addressed by other restraints) shall be restrained against excessive lateral movement during a seismic event using lateral resilient snubbers, designed to withstand the expected seismic forces.

b. A minimum of three (3) snubbers shall be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.

c. Snubbers shall be of steel construction and shall be attached to the building structure and equipment in a manner consistent with anticipated design loads.

d. Snubbers shall limit equipment movement at each snubber location to a maximum of 0.25" (6 mm) in any direction.

e. Snubbers shall include a minimum 0.25" (6 mm) thick resilient pad to cushion any impact and to avoid any potential for metal-to-metal contact.

f. Snubbers shall be installed without significantly degrading the vibration isolation capabilities of the isolator during normal equipment operating conditions.

6. Type H (Omni-Directional External Seismic Snubber Assembly)

a. Equipment shall be restrained using omni-directional resilient snubbers, designed to withstand the expected seismic forces.

b. A minimum of four (4) snubbers shall be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.

c. Snubbers shall be of steel construction and shall be attached to the building structure and equipment in a manner consistent with anticipated design loads. Snubber clearances shall be limited to a maximum of 0.25" (6 mm) in any direction.

d. Snubbers shall include resilient pads with a minimum thickness of 0.25" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact.

e. Snubber shall be installed without significantly degrading the vibration isolation capabilities of the isolator during normal equipment operating conditions.

7. Type I: Horizontal Single-Axis External Seismic Snubber Assembly

a. Stable equipment (where uplift forces are zero or are addressed by other restraints) shall be restrained against excessive lateral movement during a seismic event by the use of horizontal single-axis resilient snubbers designed to withstand the expected seismic forces.

b. A minimum of four (4) snubbers are to be used at each equipment installation, oriented to effectively restrain the isolated equipment in all lateral directions.

c. Snubbers shall be of steel construction and shall be attached to the building structure and equipment in a manner consistent with anticipated design loads.

d. Snubber clearances shall be limited to a maximum of 0.25" (6 mm) in any direction.

e. Snubbers shall include resilient pads with a minimum thickness of 0.25" (6 mm) to cushion any impact and to avoid any potential for metal-to-metal contact.

f. Snubbers shall be installed without significantly degrading the vibration isolation capabilities of the isolator during normal equipment operating conditions.

8. Type J (Cable Restraints for Suspended Components and Systems)

a. Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist expected seismic loads and to restrain suspended components and systems in all lateral directions.

b. Protective thimbles shall be used to eliminate potential for dynamic cable wear and strand breakage, if required.

c. Restraint system shall be sized to the capacity of the cable or to the capacity of the anchorage, whichever is less.

d. Anchor load is to be calculated taking into account the geometry of the bracket.

e. Seismic wire rope connections shall be made using overlapping wire rope "U" clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.

f. Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical compression forces.

g. Braces shall be selected to be of sufficient strength and size to prevent support rod buckling.

1) Braces shall be attached to the vertical suspension rod by a series of attachment clips.

h. Where clevis hanger brackets are used for seismic restraint attachment, the cross bolt shall be fitted with internal bracing to prevent deformation of the clevis hanger.

9. Type K (Rigid Restraints for Suspended Components and Systems.)

a. Rigid restraints shall consist of structural elements, sized to resist expected seismic loads and to restrain suspended components and systems in all lateral directions.

b. Structural element shall be capable of carrying both compressive and tensile loading.

c. Restraint system shall be sized to the capacity of the cable, or to the capacity of the anchorage, whichever is less.

d. Anchor load shall be calculated taking into account the geometry of the bracket.

e. Anchorage of static support system shall be capable of carrying the additional tension loads generated by the compression of the rigid brace.

1) This is the vertical component of the compressive force in the brace.

2) This load is additive to any static load requirements on the system.

f. Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical compression forces.

g. Braces shall be selected to be of sufficient strength to prevent support rod buckling.

1) Brace shall be attached to the vertical suspension rod by a series of attachment clips.

h. Where clevis hanger brackets are used for seismic restraint attachment, the cross bolt shall be fitted with internal bracing to prevent deformation of the clevis hanger.

10. Type L (Roof Curbs (Non-Isolated))

a. Curbs or fabricated equipment piers used to attach rooftop equipment to the structure shall be of steel construction and shall be attached to the equipment as specified by the manufacturer.

b. Contractor shall be responsible for proper seismic attachment of rooftop curb to building structure.

c. Contractor shall be responsible for coordinating the location of adequate structural support for the rooftop curb.

d. Components exposed to the weather shall be galvanized or manufactured out of corrosion resistant materials.

11. Type M (Roof Curbs (Isolated))

a. Curbs or fabricated equipment piers used to attach rooftop equipment to the structure shall be of steel construction and shall be attached to the equipment as specified by the manufacturer.

b. Contractor shall be responsible for proper seismic attachment of rooftop curb to building structure.

c. Contractor shall be responsible for coordinating the location of adequate structural support for the rooftop curb.

d. Curbs or piers shall be fitted with snubbers capable of resisting all anticipated design load conditions.

e. Snubber clearances in all planes shall be limited to a maximum of 0.25” (6 mm) in any direction.

f. Snubbers shall include a minimum 0.25” (6 mm) thick resilient pad to cushion any impact and to avoid any potential for metal-to-metal contact.

g. Snubber shall be installed without significantly degrading the vibration isolation capabilities of the isolator during normal equipment operating conditions.

h. Components exposed to the weather shall be galvanized or manufactured out of corrosion resistant materials.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. Painting shall be in accordance with Section 09 91 90 – Painting.

2. All internal and external metal surfaces of the V&SC devices shall be thoroughly cleaned, rinsed, and phosphatized prior to painting.
3. All steel components shall be cleaned of welding slag and coated with an approved primer.
4. All steel components (excluding springs) on projects exposed to the weather, shall be hot dip galvanized or powder coated.
5. Springs shall be cadmium or zinc plated, powder-coated, epoxy or PVC finished.
6. The V&SC devices shall be painted with a thermosetting electrostatically applied polyester powder with final baked on average thickness between 1.5 to 2.0 mils.
7. The color of all interior finishing coats shall be the manufacturer's standard.
8. The color of the exterior finishing coats shall be the manufacturer's standard.
9. The finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass ASTM B117 5% salt spray test for a minimum of 1000 hours.
10. A supply of touch-up paint shall be provided from paint used for the final coat.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine areas and equipment to receive V&SC devices and building expansion/seismic joint for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine rough-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected and approved by of the Engineer.

3.02 INSTALLATION

A. Vibration Control Devices

1. VCDs shall be installed in accordance with the manufacturer's instructions and recommendations.

2. VCDs shall not be installed in a manner that will result in equipment stress or misalignment.
3. Isolated equipment or components shall not be installed in manner that makes rigid connections with the building structure unless isolation is not specified:
    a. Building structure includes, but is not limited to, slabs, beams, columns, studs, and walls.
    b. Coordinate Work with other trades to avoid rigid contact with the building structure.
4. Upon completion of installation of all equipment and VCDs and before adjusting the VCDs, all debris shall be cleaned from beneath the isolated equipment, to avoid the possibility of short-circuiting the isolation system.
5. The Contractor shall notify the local representative of the vibration isolation manufacturer prior to installing any vibration isolation devices. The Contractor shall seek the representative's guidance in any installation procedures with which he is unfamiliar.

B. Seismic Control Devices
1. SCDs shall be installed as per the manufacturer's written instructions.
2. SCDs shall not be installed in a manner that will result in equipment stress or misalignment.
3. Isolated equipment or components shall not be installed in manner that makes rigid connections with the building structure unless isolation is not specified:
    a. Building structure includes, but is not limited to slabs, beams, columns, studs, and walls.
    b. Coordinate Work with other trades to avoid rigid contact with the building structure.
4. Upon completion of installation of all SCDs and before startup of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers.
5. All external utility connections to restrained equipment shall be designed to allow differential seismic motion without damage to the equipment or utility connections.
6. Adjust isolators and restraints after systems have been filled and equipment is at its operating weight, following manufacturer's written instructions.

7. After equipment installation is completed, adjust limit stops following manufacturer's written instructions so they are out of contact during normal operation.
8. Adjust snubbers according to manufacturer's written instructions.
9. Torque anchor bolts according to anchor manufacturer's written instructions to resist seismic forces.
10. V&SCS equipment shall be installed in accordance with manufacturer's instructions and recommendations.
11. V&SCS equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.
12. V&SCS equipment shall be installed on concrete pads at locations shown on the Contract Drawings.
13. Steel channels shall be provided for support of V&SCS equipment.
14. V&SCS equipment shall be securely mounted to mounting surface with anchor bolts.
15. Anchor V&SCS to satisfy the specified seismic requirements in accordance with the anchorage details.
16. Install nameplates for identification of V&SCS equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, V&SCS shall be field tested for operation and conformance.
2. The Contractor shall perform field tests in accordance with this Section and Specifications.
3. The field tests shall be witnessed by the Engineer and certified by the Contractor.
4. V&SCS testing shall be performed by the manufacturer's representative, prior to energizing equipment.
5. Equipment shall not be energized without the permission of the Engineer.
6. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:
    a. Contractor shall conform to the manufacturer's industry standard tests.

B. Upon completion of the installation of all vibration isolation devices herein specified, the local representative of the vibration isolation manufacturer shall, at

the Contractor's request, inspect the completed system and report in writing any installation errors or other fault in the system which could affect the performance of the system.

C. The installing Contractor shall submit a report upon request to the Engineer, including the manufacturer's representative's final report, indicating that all vibration isolation material has been properly installed, or steps that are to be taken by the Contractor to properly complete the vibration isolation work as per the Specifications.

D. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the V&SCS, check the V&SCS installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the V&SCS.

2. The Contractor shall provide V&SCS equipment start-up services and training in accordance with this Section, the Specifications, and the Contract Drawings and the following requirements:

3. Minimum number of manufacturer's representative site visits per V&SCS:

Visit Type	Min. No. of Visit(s)	Min. No. of Person(s) per Visit	Min. Number of Day(s)
Equipment Installation & Inspection	1	5	5
Field Tests	1	3	5
Acceptance Testing	1	3	5
Training	1	3	3

4. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

5. The Engineer shall have the right to reallocate any unused person-days.

6. The Contractor shall provide a field report from the manufacturer's representative for each visit to the Site.

   a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

7. The service representative shall sign in and out with the Engineer on each day they are at the Site.

a. Person-days shall be understood to be the actual time spent at the Site and does not include travel to and from the Site.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide V&SCS start-up services and Training in accordance with this Section and the Specifications.

1. Acceptance Testing
2. The Contractor shall provide acceptance testing of the V&SCS.
3. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.
4. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.
5. Acceptance testing inspection shall be performed on each V&SCS. Inspection shall include the following:
   a. Physical, electrical, and mechanical condition shall be inspected.
   b. Proper anchorage required area clearances, physical damage and proper alignment shall be checked.
   c. Ventilating air passageways shall be inspected for blockage.
   d. All connections shall be inspected for high resistance.
   e. Electrical and mechanical interlock systems shall be checked for proper operation.
   f. Insulators shall be inspected for evidence of damage or contamination.
   g. Equipment shall be cleaned and lubricated as required.
6. Acceptance electrical testing shall be performed on each V&SCS. Testing shall include the following:
   a. Ground-resistance tests shall be performed.
   b. Insulation-resistance tests shall be performed on each bus section, on each switch, transformer and circuit breaker, phase-to-phase, and phase-to-ground.
   c. An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.
   d. Contact-resistance test shall be performed.
   e. Control and metering wiring performance test shall be performed.

f. Circuit breaker trip characteristics shall be determined by primary current injection.

g. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.

h. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Upon completion of the installation of all vibration isolation devices herein specified, the local representative of the vibration isolation manufacturer shall, at the Contractor's request, inspect the completed system and report in writing any installation errors or other fault in the system which could affect the performance of the system.

B. The installing Contractor shall submit a report upon request to the Engineer, including the manufacturer's representative's final report, indicating that all vibration isolation material has been properly installed, or steps that are to be taken by the Contractor to properly complete the vibration isolation Work as per the Specifications.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing labeling and identification.

1. Labeling and identification shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

2. Labeling and identification shall be provided for the identification of electrical equipment.

B. The work shall include providing all voltage signs, equipment nameplates, markers, tags, and arc flash labels for all electrical equipment furnished under this Contract.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 14 - Medium-Voltage Cables and Accessories

B. Section 26 05 20 - Low-Voltage Cables and Accessories

C. Section 26 05 33 - Raceways and Boxes for Electrical Systems

D. Section 26 05 73 - Power System Studies

E. Section 26 05 75 - Shock Hazard and Arc Flash Studies

F. Section 40 05 97 - Identification for Process Equipment

1.04 REFERENCES

A.	NEC	-	National Electrical Code.
B.	NFPA 70E	-	Standard for Electrical Safety in the Workplace.
C.	IEEE 1584	-	IEEE Guide for Performing Arc-Flash Hazard Calculation
D.	ANSI Z535.4	-	American National Standard for Product Safety Signs and Labels.
E.	OSHA 1910 Subpart S	-	Electrical.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. All labeling and identification signs and nameplates shall be provided in accordance with the NEC, NFPA 70E and OSHA 1910 Subpart S.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include but not be limited to:

1. Submit signs, nameplates and other labeling and identification devices proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The labeling and identification devices shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer’s recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Labels shall be as manufactured by:

1. Brady, Milwaukee, WI;
2. Seton Nameplate Corporation, North Branford, CT;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. High Voltage Signs

1. High voltage signs shall be provided for equipment operating over 600 volts.
2. High voltage signs shall be fiberglass reinforced polyester, rigid acrylic, or aluminum plate 1/16-inch thick. Finish shall be industry standard of red, white, and black graphics. Signs shall be 10 inches by 14 inches with the following exceptions:
3. Use 7-inch by 10-inch signs where this is the largest size that can be applied.
4. Use 14-inch by 20-inch signs where needed for adequate vision.
5. High voltage signs shall read; "DANGER - HIGH VOLTAGE KEEP OUT".
6. High voltage sign mounting screws shall be 3/16-inch diameter, round head, stainless steel, and self-tapping type.

B. Equipment Nameplates

1. Equipment nameplates shall be provided in addition to the manufacturer’s nameplate, to identify the equipment number and the item’s function and the equipment to which it serves.
2. Equipment nameplates shall be provided in accordance with the requirements specified under this Section and Section 40 05 97 – Identification for Process Equipment.
3. Equipment nameplates shall be laminated plastic with black letters on a white background.
4. Nameplates for equipment identification shall have 1/2-inch-high letter engravings.
5. Nameplates for pilot device identification shall have 1/4-inch-high letter engravings.

6. Nameplates for distribution equipment shall have the following information:
   a. Equipment name and number.
   b. Voltage.
   c. Phases and number of wires.
7. Pull boxes, junction boxes and control stations shall have a nameplate identifying the equipment name and number.
8. All feeders and branch circuit devices shall have nameplates identifying the served equipment name and number.
9. Where execution of the work under this Contract requires certain feeders and branch circuit devices to be modified, the Contractor shall provide new nameplates reflecting the modifications. The nameplates shall identify the served equipment name and number.
10. All control and indicating devices shall have individual nameplates identifying device function.
11. Nameplate mounting screws shall be 3/16-inch diameter, roundhead, stainless steel, and self-tapping type. Adhesives shall not be used.

C. Conduit Markers and Tags
1. Conduit markers and tags shall be provided for the identification of the electric conduit system.
2. Conduit markers and tags shall be in accordance with Section 26 05 33 - Raceways and Boxes for Electrical Systems.

D. Cable and Wire Markers
1. Cable and wire markers shall be provided for the identification of the electric wire and cable.
2. Cable and wire markers shall be in accordance with Section 26 05 14 - Medium-Voltage Cables and Accessories and Section 26 05 20 - Low-Voltage Wires, Cables and Accessories.

E. Arc Flash Labels
1. Labels shall be provided in addition to the manufacturer's nameplate and equipment nameplate, to identify equipment name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
2. Labels shall be able to withstand their usage environment, the print shall not fade, and adhesive should be aggressive enough to avoid peeling.

3. Arc flash labels shall be printed on a durable polyester base over-laminated to protect the text and graphics.
4. The back of the labels shall employ an acrylic adhesive, which allows the labels to be securely and permanently affixed to a wide range of surfaces.
5. Labels shall include no field markings.
6. Labels shall be generally in accordance with ANSI Z535.4.
7. Labels shall include at a minimum the following information based on the Arc Flash Hazard Analysis performed:
   a. Nominal Voltage of the Equipment
   b. Flash Protection Boundary
   c. Personal Protective Equipment category at the working distance
   d. Arc Flash Incident Energy Value (cal/cm²) at the working distance
   e. Limited and Restricted Boundaries
   f. Study Report Number and Issue Date
   g. Location of Study Report.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Signs and Nameplates
   1. All signs, nameplates and tags shall be installed neatly, properly, and as recommended by the manufacturers.
   2. Signs and nameplates shall be mounted with screws.
      a. Where mounting of signs or nameplates with screws is impractical, the Contractor shall alert the Engineer.

B. High Voltage Signs
   1. High voltage signs shall be installed on equipment operating at over 600 volts. High voltage signs shall also be installed on sides of fences or walls which enclose outdoor equipment operating at over 600 volts.

C. Signal Wire and Cable

1. Control, signal and status wire and cable shall be identified by a unique number. The numbering system shall reflect the actual identification used in the work and shall be documented on the point-to-point wiring diagrams.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Power System Studies and field testing. The Contractor shall provide Power System Studies and field testing in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

B. The Power System Studies shall include a load flow study, a short circuit study, a protective device evaluation study and a protective device coordination study for a completely coordinated power distribution system. Power System studies shall include other studies as applicable including but not limited to motor starting and harmonic studies.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements.

B. Section 26 05 53 - Identification for Electrical Systems.

C. Section 26 05 75 - Shock Hazard and Arc Flash Studies.

D. Section 26 08 11 - General Electrical Testing.

1.04 REFERENCES

A. Definitions

1. Power System as used in this Section shall mean all of the electrical distribution network from the Utility connection to all loads. This includes all on site generating sources, all branches and all nodes.

2. Low-Voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volts and within the 600 Volts Class.

3. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 volts and below 99000 volts.

4. Node as used in this Section shall mean any point in the Power System where two or more pieces of electrical equipment connect.

5. Branch as used in this Section shall mean any element of the Power System connecting any two nodes.

6. Major Node as used in this Section shall mean any node representing actual real world connection points of branches of the Power System such as busses in service entrance switchgears, Unit Substations, MCCs or panelboards or the connection points of cables to load and equipment.

7. Dummy Node as used in this Section shall mean any fictitious node created within the modelling software to facilitate modelling of the Power System.

8. Major Branch as used in this Section shall mean any branch representing actual real world elements of the Power System such as feeders, breakers, transformers, and cables.

9. Dummy Branch as used in this Section shall mean any fictitious branches created within the modelling software to facilitate modelling of the Power System.

10. All references to the Electric Utility or Utility shall mean the Local Electric Utility having jurisdiction as defined in this Section.

11. The Electric Utility is Con Edison.

12. Harmonic Sources as used in this Section shall mean

a. All equipment drawing non-linear currents and causing the voltage and currents at the node to which they are connected and other nodes to exhibit non-linear voltage and current characteristics. Equipment includes:

1) Convertors in variable frequency drives and switch mode power supplies.

2) Semiconductor switches modulating the voltage in soft starters, light dimmers and electronic ballast.

b. Utility sources whose waveforms are distorted dues to non-linear loads at other consumers on the Utility network.

13. Point of Common Coupling (PCC) is the node where the Power System is connected to the Utility.

a. Subordinate PCCs may be also defined at the nodes within the Power System where the equivalent network of the Utility and the Power System and specific harmonic sources are connected.

b. PCCs are shown on the Contract Drawings.

B. Reference Standards

1.	NEC	-	National Electrical Code.
2.	IEEE C37.04	-	IEEE Standard Rating Structure for AC High Voltage Circuits Rated on a Symmetrical Basis
3.	IEEE C37.010	-	IEEE Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Basis
4.	IEEE C37.13	-	IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
5.	IEEE 141	-	IEEE Recommended Practice for Electric Power Distribution in Industrial Plants
6.	IEEE 399	-	IEEE Recommended Practice for Industrial and Commercial Power System Analysis
7.	IEEE 519	-	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
8.	IEEE 1015	-	IEEE Recommended Practice for Applying Low-Voltage Breakers Used in Industrial and Commercial Power Systems
9.	IEEE 3002.2	-	IEEE Recommended Practice for Conducting Load-Flow Studies and Analysis of Industrial and Commercial Power Systems.

10.	IEEE 3002.3	-	IEEE Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems.
11.	IEEE 3002.7	-	IEEE Recommended Practice for Conducting Motor-Starting Studies and Analysis of Industrial and Commercial Power Systems.
12.	IEEE 3002.8	-	IEEE Recommended Practice for Conducting Harmonic Studies and Analysis of Industrial and Commercial Power Systems.
13.	NETA ATS	-	NETA Acceptance Testing Specification.

1.05 DESCRIPTION

A. Power Systems Studies shall be completed by modelling the entire low-voltage and medium-voltage equipment of the Power System in the software detailed in this Section. The studies shall encompass existing systems and the proposed systems.

B. The model shall comprise all major nodes and major branches of the Power System.

C. The model shall also comprise dummy nodes and dummy branches to attain a level of connectivity similar to the Single Line Diagram representation of the Power System.

D. The model shall completely facilitate the examination of normal operations, and alternate operations of the Power System which could result in deviations from the normal operating values at major nodes and in major branches of the Power System.

1.06 QUALITY ASSURANCE

A. Modelling:

1. The Power System studies shall be performed in accordance with the latest applicable provisions and recommendations of the Reference Standards in this Section.

2. The Contractor shall retain the services of a Professional Engineer, licensed in the State of New York, to perform the Power System Studies.

3. The Licensed Engineer shall be from an independent consulting firm or the equipment manufacturer and shall have a minimum of five (5) years of experience in performing Industrial Power System Studies.

4. It shall be the responsibility of the Contractor' Licensed Engineer:

a. To evaluate all devices.

b. Evaluate all equipment.

c. Determine all performance indices at the PCC.

d. Establish the settings of all protection functions.

e. Establish the settings required to secure selective coordination among protective devices.

5. Power System Studies shall be completed using the software program listed in this Section.

6. The Contractor shall coordinate with the Licensed Engineer performing the studies and assist the Engineer in the collection of all information necessary to complete the studies specified.

7. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the NIST and NETA ATS.

B. Field Testing:

1. The Power System shall be field tested. The field testing shall be performed in accordance with the requirements specified under this Section.

2. The Contractor shall retain the service of an independent testing firm who shall perform field testing of the Power System. The testing firm shall have experience in the inspection and testing of the system equipment and shall be a member company of NETA. Provide proof of membership, or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

1.07 SUBMITTALS

A. Submittals

1. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

a. Experience of the Licensed Engineer who will perform the Power Systems Studies

b. Version of the software to be used to conduct Power Systems Studies

c. Calculations and results of the Power System Studies shall be submitted. The submission of calculation and results shall consist of:

1) A report detailing all the findings, recommendations and settings arising from the studies. The report shall be stamped and signed by the Licensed Engineer.

2) The complete software files produced by the study software, and corresponding to the findings, recommendations and settings contained in the report. Two (2) copies of the software files shall be submitted, one (1) copy shall be write protected and the other shall not.

2. The Power System Studies shall be submitted for approval prior to receiving the final approval of the Power System equipment and/or prior to the release of equipment drawings for manufacturing.

3. Power System Studies shall be submitted for approval prior to the Engineer giving approval for drawings to be submitted for review by the Utility.

4. In the event that formal completion of the Power System Studies may cause delay in the approval of equipment or Utility drawings then a preliminary submission of the Power System Studies shall be made. The Engineer will determine whether the preliminary submission is sufficient to allow approval of equipment and Utility drawings.

5. Work sequence for the field testing shall be submitted. The sequence shall indicate the schedule of work, time frame and downtime for the equipment. The work sequence shall be submitted at least sixty (60) days in advance prior to conformation of field testing dates.

6. Qualifications of proposed testing firm to perform field testing shall be submitted. Submit firm experience records at least 60 days in advance to actual testing along with five (5) recent references with phone numbers.

B. Reports

1. Field test report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Power Systems Analysis Software shall be as manufactured by

1. Power Analytics Corporation, Raleigh NC;

2. Electrical Power System Analysis by ETAP,

3. SKM System Analysis, Inc.,

4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Load Flow Study:

1. The load flow study shall be preliminary to all the other studies and for all proposed operating conditions of the Power System. The load flow study shall be used to

a. Preset the study parameters as applicable for each of the studies listed under this Section.

b. Confirm the layout and balance of the power flows across the major branches

c. Establish the voltage profiles at all major nodes.

d. Identify real and reactive power flows into nodes and across the branches of the Power System.

e. Determine real and reactive power losses in the Power System.

f. Identify proposed transformer tap settings.

g. Problem areas or equipment capacity inadequacies shall be promptly brought to the Engineer's attention.

B. Short Circuit Study:

1. Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each major node and through major branches and other significant locations through the system.

2. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios.

3. For each fault location, the total duty on the major nodes, as well as the individual contribution from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.

C. Protective Device Evaluation Study:

1. The protective device evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the prospective fault currents.

2. Appropriate multiplying factors based upon system X/R ratios and protective device rating standards shall be applied.

D. Protective Device Coordination Study:

1. The protective device coordination study shall be performed to select or to check the selections of the power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage

and current transformers, and low-voltage breaker trip characteristics and setting.

2. The device settings computed in the coordination study shall provide complete selectivity.
   a. The system shall be selectively coordinated such that only the device nearest a fault will operate to remove a faulted circuit.
   b. System selectively shall be based on both the magnitude and the duration of a fault current.
3. The coordination study shall include all voltage classes of equipment starting at the utility's incoming feeder protective device down to and including each of the medium and low voltage load. The phase and ground overcurrent and ground fault protection shall be included, as well as settings for all other adjustable protective devices.
4. The time-current characteristics of the installed protective devices shall be plotted on the appropriate log-log paper. Reasonable coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a complete system basis. Sufficient curves shall be used to clearly indicate selective coordination achieved to the utility main breaker, power distribution feeder breakers, and the overcurrent devices at each major load center.
5. There shall be a maximum of six protective devices per plot. Each plot shall be appropriately titled. Plots shall include the following information as required for the circuits shown:
   a. Representative one-line diagram, legend and types of protective devices selected.
   b. Utility’s relays or fuse characteristics.
   c. Significant motor starting characteristics.
   d. Parameters of transformers, ANSI magnetizing inrush and withstand curves.
   e. Operating bands of low voltage circuit breaker trip curves, and fuse curves.
   f. Relay taps, time dial and instantaneous trip settings.
   g. Cable damage curves.
   h. Symmetrical and asymmetrical fault currents.
6. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of

adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system.

E. Harmonics Study:

1. Provide a harmonics study for the Power System including Utility and alternate sources.
2. The goal of the Harmonic Study shall be:
   a. To identify and quantify all distortions in voltage and current waveforms in the Power System.
   b. To identify and quantify all resonances in the Power System.
   c. To evaluate the performance of the Power System at the PCC under all conditions of normal and alternate operations, ensuring compliance with the Recommended Harmonic Limits of IEEE 519 and or IEEE 3002.8.
   d. To ensure that all remedial measures required to achieve the Recommended Harmonic Limits and mitigate resonances are incorporated into the Power System.
3. Capacitor-Inductor filter traps that require tuning to the power system are not acceptable.
4. The Contractor along with manufacturer of harmonic sources shall provide for the design, furnishing and installation of the remedial measures and appurtenances required to meet the requirements of the Harmonic Study.
5. The Contractor along with the manufacturer of harmonic sources is responsible to provide an updated single line diagram with referenced data within the submittal for this study.
6. The report shall be provided for approval prior to or with the shop drawings of the harmonic sources.
7. Submittals of harmonic sources prior to or without the study will be considered incomplete and not reviewed.
8. The report shall be provided for approval prior to or with the shop drawings of the harmonic sources. Submittals of harmonic sources prior to or without the study will be considered incomplete and not reviewed.

F. Motor Starting Studies

1. Provide Motor Starting Study/Studies to determine the impact of the selected motor starting method/s proposed for this Contract.
2. Motor Stating Study/Studies shall be completed in accordance with IEEE 399 and or IEEE 3002.7
3. The Motor Starting Study/Studies shall include:

a. Starting Analysis for all motors 150 HP and above or all motors whose starting impact is significant in relation to the Power System of this Contract.

b. Starting Analysis shall also be completed for less than 150 HP motor/s where the following are impacting performance:

   1) Variations in nominal or service voltage.

   2) Size and length of feeder cable.

   3) Simultaneous starting of groups of less than 150 Hp motors.

c. Determination of the impact of starting at motor bus and remote busses including but not limited to:

   1) Motor/s will start with acceptable voltage drop.

   2) Motor/s will accelerate within acceptable start-up times.

   3) Motor/s are not subjected to nuisance tripping.

   4) Voltage deviations will not disrupt loads at the motor bus and remote busses inclusive of stall of running motors.

   5) Accurate evaluation of motor/load torque-speed characteristics.

   6) Accurate assessment of motor/s life as a function of the starting method selected and thermal damage characteristics.

   7) Voltage deviations causing variable performance of solid state and electronic equipment.

   8) Voltage deviations causing lighting system/s flicker

   9) Confirmation of the type of controller required to start the motor/s.

   10) Confirmation of motor/s feeder sizes.

d. Recommendations to alleviate starting deficiencies identified by the Study/Studies.

   1) All motors and controllers identified in the Motor Starting Study/Studies requiring specific measures to mitigate disturbances at connected and remote busses shall not be submitted without the mitigation measures clearly identified in the respective submittals.

e. Evaluation of all motor starting when the Power System is connected to the Utility or alternative on site Power Sources.

4. The report shall be provided for approval prior to or with the shop drawings of the harmonic sources. Submittals of harmonic sources prior to or without the study will be considered incomplete and not reviewed.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Study Input

1. The Contractor shall be responsible to ensure that all data to complete the Power System Studies is provided and is input to the software model including but not limited to:

a. Selection of suitable base MVA, base voltage and base current.

b. Utility and on site generation, single and three phase fault current contributions including X/R ratios.

c. Motor contributions and sequence impedances including X/R ratios.

d. Sequence resistance and reactance of all major branches.

e. Transformer impedance, X/R ratios, winding connection, tap ranges and base ratings.

f. Models, test results or characterization of Harmonic Sources.

g. All other circuit parameter to permit the complete and accurate modelling of the Power System.

3.02 INSTALLATION

A. Study Report

B. The results of the Power System Studies shall be summarized in a final typewritten report. The report shall include the following Sections:

1. Executive Summary, Description, purpose, basis, written scope

2. Load Flow

a. Tabulations of load flow study results inclusive of normal, minimum and maximum branch loadings along with normal, minimum and maximum voltages at nodes.

b. Tabulations of power losses for the Power System elements and the total power loss for the Power System.

3. Short Circuit

a. Tabulations of short circuit study results including a definition of terms and guide for interpretation.

4. Protective Device Evaluation

a. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties, and commentary regarding same.

5. Protective Device Coordination

a. Protective device time versus current coordination curves.

b. Tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

c. Tabulation of appropriate tap settings for relay seal-in units.

6. Harmonic Study.

a. Tabulation of Harmonic Sources including all VFDs operating simultaneously operating over their speed range under normal and alternate operations of the Power System.

b. Branch and node voltage and current harmonic current as a percentage of the 60 Hz fundamental up to the fiftieth harmonic, inclusive of the simultaneous operation of harmonic sources to meet specific actual loadings of the Power System.

c. All calculations used to arrive at the recommendations.

d. Explanation of the methods used to perform the study.

e. Explanation of study results with specific recommendations on filters and/or other measures that will be implemented to meet the specified limits or mitigate expected resonances.

7. Diagrams

a. Single line diagram along with suitable and relevant back annotation shall be included for each alternative of the Power System studied.

b. An impedance diagram along with suitable and relevant back annotation shall be included for each alternative of the Power System studied.

8. Software Model Files

a. The Contractor shall provide two copies of the software files used to provide the Power System Studies

1) One copy of the software file shall be write protected and shall be capable of all its elements being viewed in the software program stated in this Section.

2) The second copy of the software file shall not be write protected and shall be capable of all its elements being modified by the software program stated in this Section.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Testing

1. The Contractor shall provide field testing of the Power System.
2. All field testing shall be performed by the testing firm, after the completion and approval of the Power System Studies.
3. The field testing shall be witnessed by the Engineer and certified by the Contractor.
4. The testing firm shall adjust, set, calibrate and test all protective devices. All protective relays and meters in the medium and low voltage equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturer's recommendations, the coordination study and best industry practice.
5. Proper operation of all equipment associated with the device under test and its compartment, shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.
6. All solid state trip devices shall be checked and tested for setting and operation.
7. Circuit breakers and/or contactors associated with the trip devices shall be tested for trip and close function with their protective device.
8. Testing shall be performed at each major node to which harmonic sources are connected to determine if the predicted recommendations of the Harmonic Study have been achieved.
9. Test will measure and compare the harmonic levels with respect to those detailed in the Harmonic Study.
10. All harmonic levels of voltage and current which do not meet the recommendations of the Harmonic Study shall be corrected at the Contractor's expense.
11. All tests shall be in accordance with the manufacturer's recommendations and NETA, ATS.
12. The Contractor shall provide a field testing report. The report shall be in accordance with NETA, ATS.

3.04 STARTUP / DEMONSTRATION

A. Maintenance of Operations

1. Since the field testing work specified shall require that equipment be taken out of service, the Contractor shall perform field testing with due regard to maintenance of operations and construction staging in accordance with this Section and the Specifications.
2. All testing procedures and schedules must be scheduled in advance prior to any work beginning.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Shock Hazard and Arc Flash studies: Studies for determining Shock Hazard Boundaries and Arc Flash Incident Energies, in and around all electrical equipment, and notifying all personnel of boundaries and energies, shall be provided in accordance with the requirements of the Contract Drawings and the Specifications and this Section.

B. The Shock Hazard and Arc Flash Studies shall include a short circuit study and a protective device coordination study. Approval shall be obtained for the use of information from existing short circuit and protective device coordination studies.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements

B. Section 26 05 53 - Identification for Electrical Systems

C. Section 26 05 73 - Power System Studies

1.04 REFERENCES

A. Definitions

1. AC - Alternating Current
2. DC - Direct Current
3. Electric Utility or Utility - Consolidated Edison Company of New York
4. Arc Flash Studies - Shock Hazard and Arc Flash Studies
5. AFIE - Arc Flash Incident Energy
6. SHB - Shock Hazard Boundary
7. PE or Professional Engineer or Licensed Engineer - Licensed Professional Engineer in the State of New York
8. PPE-Personal Protective Equipment

B. Reference Standards. The Shock Hazard and Arc Flash Studies shall comply with the latest applicable provisions and recommendations of the following:

1. ANSI Z535.4 - Product Safety Signs and Labels
2. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
3. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
4. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power System Analysis
5. IEEE 1015 - IEEE Recommended Practice for Applying Low-Voltage Breakers Used in Industrial and Commercial Power Systems
6. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations
7. IEEE C37.04 - IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
8. IEEE C37.010 - IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
9. IEEE C37.13 - IEEE Standard for Low-Voltage Power Circuit Breakers used in Enclosures.
10. NFPA 70E - Standard for Electrical Safety in the Workplace

11. NEC - National Electrical Code

12. OSHA 1910 Subpart S - Electrical

1.05 DESCRIPTION

A. AC Arc Flash Study Outline. The AC arc flash study shall be conducted on all electrical equipment powered by AC sources. The equipment to be studied shall include all electrical equipment from the Electric Utility Point of Service (POS) to the electrical energy utilization point. This includes but is not limited to:

1. All sources of energy including the electric utility, alternative energy sources, emergency generators, legally required generators, optional standby generators and motors.

2. All medium and low-voltage equipment inclusive of equipment of nominal operating voltage less than 120 VAC.

3. All medium and low-voltage electric distribution equipment including but not limited to Primary and Secondary Unit Substations, Service Entrance switchgears, current limiting reactors, motor control centers (MCC), distribution and lighting panelboards, automatic transfer switches (ATS) and control panels.

4. All feeder and branch circuits.

5. All protective devices.

B. DC Arc Flash Study Outline. The DC arc flash study shall be conducted on all electrical equipment powered by DC Sources. The equipment to be studied shall include all electrical equipment from DC sources to the electrical energy utilization point. This includes but is not limited to:

1. Central Battery Systems

2. DC Panelboards and circuit breakers, DC Disconnect Switches, and other DC equipment

C. Arc Flash Study Modes

The arc flash study shall be conducted for different modes of electric equipment operation and the modes producing the most severe arc flash incident energy and the most restrictive shock hazard boundary shall be selected for the display on the required labels. Modes will be as directed by the Engineer but at a minimum shall be as listed below:

1. Mode 1 – All electric utilization equipment which are normally operated, are in the ON STATE and connected in their normal configurations to the normal sources. In the normal configuration, devices such as tie breakers which are normally in the open state remain in the open state for this mode.

2. Mode 2 – As Mode 1 but with all electric utilization equipment in the OFF STATE.

3. Mode 3 – All emergency and standby electric utilization equipment are in the ON STATE and connected to sources activated by the loss of the normal sources.

4. Mode 4 – As Mode 3 but with all emergency and standby electric utilization equipment in the OFF STATE.

1.06 QUALITY ASSURANCE

A. General:

1. Arc Flash Studies shall be completed using the approved computer software programs detailed in this Section.

2. Arc Flash Studies completed manually will not be accepted.

3. The Arc Flash Studies shall be performed in accordance with the latest applicable provisions and recommendations of the Reference Standards listed in this Section.

4. The Contractor shall retain the services of a Licensed Professional Engineer to perform Arc Flash Studies. The Licensed Engineer shall be from an independent engineering firm, or as directed by the Engineer. The Licensed Engineer shall have at least five (5) years' experience in conducting Industrial Power System Studies inclusive of Arc Flash Studies for projects of similar scope.

5. The Contractor shall coordinate with the Licensed Engineer performing the studies whether or not the Licensed Engineer has been selected by the Contractor, and assist the Licensed Engineer in the collection of all information necessary to complete the studies specified.

1.07 SUBMITTALS

A. Submittals General

1. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of this Section and the Specifications.

a. Qualifications of proposed Licensed Professional Engineers/ Engineering firms that will conduct arc flash studies shall be submitted.

1) Submit firm experience records demonstrating at least five (5) years conducting power system studies inclusive of shock hazard and arc flash studies along with the contact information of five (5) references for installations where arc flash studies have been completed.

2) The contact information shall include name, phone numbers, email and address of the references.

3) The contacts shall be able to speak about the work done at the reference locations.

b. Confirmation of the name and version of the approved software package that will be used in the Arc Flash Studies. The software package shall be capable of producing samples of all equipment labels recommended even if final labels will be produced by a third party vendor.

c. Calculations and results of the arc flash studies shall be submitted. The arc flash studies shall be submitted in a report format. The report shall contain recommended samples of the labels required for each type of equipment where personnel shall be required to interface with electrical equipment for operation, adjustment, repair or modification. The report shall be stamped and signed by the Licensed Engineer.

d. Electronic copies of the results of the arc flash studies shall be submitted in addition to the above report. The format of the electronic submission's files shall permit and allow the following:

1) The review of all submittals in the approved software program detailed in this Section.

2) The review of all submittals by common readers such as Adobe Acrobat.

e. Work sequence for the application of equipment labels shall be submitted. The sequence shall indicate the schedule of work, time frame and downtime if any for the equipment. The work sequence shall be submitted at least forty-five (45) days in advance prior to confirmation of field labeling dates.

B. Preliminary Arc Flash Studies

1. Preliminary Arc Flash Studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If completion of the preliminary study may cause delays in equipment shipments, approval from the Engineer shall be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. Final formal arc flash studies shall be provided to verify preliminary findings.

C. Label Application Reports

1. A report shall be submitted detailing the equipment labeled and whether it was not possible to accomplish the labeling of specific pieces of equipment and the reasons for this.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Arc Flash Study computer software shall be as manufactured by

1. Power DesignBase by Power Analytics Corporation, Raleigh NC;
2. Electrical Power System Analysis by ETAP,
3. SKM System Analysis, Inc.,
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Shock Hazard Study

1. For each piece of equipment, a shock hazard analysis complying with the requirements of NFPA70E shall be completed and shall detail the following as minimum:
   a. Equipment and subpart if applicable
   b. Nominal voltage
   c. Restricted approach boundary
   d. Limited approach boundary
   e. Flash protection boundary
   f. Short Circuit Amps
   g. Protective Device clearing time.

B. Arc Flash Study

1. The Arc Flash analysis shall cover the Modes of operation detailed in this Section, ensuring that each node is studied for each of maximum and minimum short circuit contribution of the energy sources connected to the system. The following shall be completed:

a. Confirm the results of Section 26 05 73 - Power System Studies

b. Extend the results of Section 26 05 73 - Power System Studies as required to complete the arc-flash study

c. Calculate the arc fault currents

d. Determine the protective device operating times

e. Determine the incident energies

f. Determine the flash protection boundaries

g. Determine the incident energies at the boundaries determined in the shock hazard analysis and at the working distance.

h. Determine the Hazard/Risk categories at the boundaries determined in this Section.

i. Recommend the appropriate required level of PPE for workers within the flash protection boundaries, the shock hazard boundaries and the working distance.

C. Reports

1. A report shall be submitted detailing the results of this study, and color copies of labels that will be prepared for each piece of equipment. The report shall contain at the minimum the following information:

a. Executive Summary including Introduction, Scope of Work and Results/Recommendations

b. All raw data collected and organized by common category

c. Study One Line Diagrams for each configuration

d. Impedance Diagrams for each configuration

e. Complete Fault and Protective Device Coordination Study

f. Shock Hazard/Arc Flash Analysis results, inclusive of tabular listing showing for each piece of equipment the following minimum information:

1) Equipment and Subpart

2) Nominal Operating Voltage

3) Restricted Approach Boundary

4) Limited Approach Boundary

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Approval Data Sources

1. The Contractor shall ensure that all other provisions of the Contract are satisfied inclusive of all vendors of electrical equipment has been approved, all working drawings and as built data relating to all equipment submitted and approved.

2. The Contractor shall ensure that the results of Section 26 05 73 – Power System Studies have been submitted and the settings of all protective devices have been approved.

3. The Contractor shall not commence the arc flash study until all prior studies and submittals to be reused in the arc flash study has been submitted and approved.

4. Arc Flash studies based on equipment or equipment data and settings which have not been approved, as required in an earlier stage of the project, will be rejected outright.

B. Data Collection and Modelling

1. The Contractor shall ensure that the collection of all data required to support studies under Section 26 05 73 – Power System Studies and Studies under this Section are input into a comprehensive and accurate software model of the electrical distribution system.

2. Data shall include but not be limited to:

   a. Maximum and minimum short circuit infeed data of all sources including current magnitudes, X/R ratios and sequence values.

   b. Information on all installed equipment such as cable lengths, cable sizes, and cable impedance per unit length.

   c. All data to determine clearing times of protective devices.

3. An accurate and comprehensive model of the electrical distribution system shall permit the evaluation of the short circuit currents at all nodes in the system. The model shall also permit the coordination of protection devices installed at nodes upstream and downstream of a specific node.

4. All nodes incorporated in the model shall be approved before any analyses are commenced.

3.02 INSTALLATION

A. Arc Flash Labels

1. Arc Flash labels shall be provided in accordance with Section 26 05 53 - Identification for Electrical Systems.

2. The Contractor shall affix arc flash labels to each piece of equipment.

3. The arc flash labels shall contain the results of this Section.

4. The label content and the schedule governing the placement of labels shall be approved by the Engineer before affixing the labels to the equipment.

5. Each label shall indicate location in the facility of a copy of the studies generating the labels.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Training

1. The Contractor shall conduct training of the owner's qualified electrical personnel on the potential arc flash hazards associated with the working of the energized equipment.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 26 05 91 – LOW-VOLTAGE ELECTRIC MOTORS
CONTRACT KENS-EAST - 2

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing low-voltage electric motors. Low-voltage electric motors shall be provided in accordance with the requirements specified under this Section and the Contract Drawings.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 33 – Identification for Electrical Systems.

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

B. Reference Standards

1.	AFBMA Standard 9	-	Load Ratings and Fatigue Life for Ball Bearings.
2.	AFBMA Standard 11	-	Load Ratings and Fatigue Life for Roller Bearings.
3.	API Standard 541	-	Form-Wound Squirrel-Cage Induction Motors 375 kW (500 HP) and Larger
4.	EPAct 1992	-	Energy Policy and Conservation Act of 1992
5.	EISA 2007	-	Energy Independence and Security Act of 2007
6.	IEEE 112	-	IEEE Standard Test Procedure for Polyphase Induction Testing Motors and Generators.
7.	IEEE 841	-	Premium-Efficiency, Severe Duty Totally Enclosed Fan-Cooled Squirrel-Cage Induction Motors.
8.	NEMA MG1	-	Motors and Generators.
9.	NEMA MG 10	-	Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors.
10.	NETA ATS	-	Acceptance Testing Specifications.
11.	NIST	-	US National Institute of Standards and Technology
12.	NEC	-	National Electrical Code.
13.	NYCEC	-	New York City Electrical Code.
14.	NYC EPPR	-	New York City Environmentally Preferable Purchasing Rule.
15.	UL Standard 674	-	Low-voltage electric motors and Generators for use in Hazardous Locations.
16.	UL Standard 1004	-	Low-voltage electric motors.

1.05 DESCRIPTION

A. Motor Data

1. Motor data is specified under the Section of the Specification detailing the requirements of the driven equipment with which the motor is supplied. These data include voltage, rpm, HP and enclosure types

B. Motor Types

1. The motor types specified under this Section shall include:

a. Single Phase, alternating current, fractional horsepower induction motors.

b. Three Phase, alternating current, NEMA frame, squirrel cage, induction motors.

c. Three Phase, alternating current, above NEMA frame, squirrel cage, induction motors.

d. Three Phase, alternating current, submersible, squirrel cage, induction motors.

e. Three Phase, alternating current, wound-rotor, squirrel cage, induction motors.

f. Direct current, small motors.

1.06 QUALITY ASSURANCE

A. Electric Motors shall comply with the requirements of NYC EPPR.

B. The motor manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

C. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure each motor is designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings,

D. Motor manufacturer shall use a shop test facility that has calibrated testing apparatus, inclusive of a calibrated dynamometer and qualified experienced technicians for all shop tests. Calibration of all testing apparatus shall be within one year.

E. All test equipment, instrument calibration and test reports shall be in accordance with the latest edition of the accuracy standard of The U.S. NIST and NETA ATS.

F. Nameplates shall be provided for each motor. Nameplates shall clearly indicate information in accordance with NEMA requirements. Nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins.

G. Field Tests:

1. The motors shall be field tested.
2. Field testing shall be performed in accordance with the requirements specified under this Section and the Specifications.
3. Retain the services of the motor manufacturer for field service.
4. Field service shall be in accordance with the requirements specified under this Section and the Specifications.
5. For motors larger than 200 horsepower an independent testing firm shall be retained to perform acceptance testing of the motors.
    a. The testing firm shall have experience in the inspection and testing of motors and shall be a member company of NETA.
    b. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.
    c. Acceptance testing shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. For fractional horsepower motors, data sheets showing nameplate data shall be submitted.
3. For motors rated one horsepower or greater, Motor Test Data Sheets shall be submitted. All values shall be from tests of previously manufactured, electrically duplicate motors or calculated data. Sheets shall be marked to indicate motor application location, manufacturer, type, frame size, bearing type, lubrication medium and enclosure type. Data Sheets shall at a minimum include:
    a. Winding resistances.
    b. Torques.
    c. Efficiencies.
    d. Power factors.
    e. Slip.
    f. Full load.
    g. Locked rotor and no load amperes.

h. Rotor voltage and amperes for wound rotor units.

i. Nameplates temperature and results of dielectric tests.

4. An outline drawing or an outline data sheet showing complete motor dimensions shall be submitted to cover every motor rated greater than 1/3 horsepower. Several motors of the same type and rating for the same application may be covered by a single drawing or outline sheet. Drawings or sheets shall bear complete identifying data including frame size, speed, horsepower ratings and application for each particular unit.

5. Description of proposed shop and field testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted in advance prior to conformation of witness testing dates and actual testing as follows:

   a. At least 60 days in advance for test locations in the US.

   b. At least 90 days in advance for test location outside of the US.

6. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 60 days in advance to actual testing, five recent references with phone numbers shall be submitted.

7. All motor accessories, heaters, detectors, sensors, etc., shall be submitted.

8. Bill of Materials for the proposed motors shall be submitted.

B. Certificates of Compliance:

1. Certified copies of motor characteristic curves and all other data necessary for establishing control and protective equipment settings shall be submitted.

2. Results of shop tests shall be certified. When routine tests are made in conjunction with complete initial tests, unwitnessed results shall be certified and copies shall be submitted. Results shall be included for each test.

3. Data and results of witness tests shall be submitted with copies of certified initial tests, accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed and the Engineer shall be notified of the arrival date.

C. Reports:

1. Shop test and field test reports shall be submitted.

2. Manufacturer’s site visit and acceptance testing reports shall be submitted.

D. Operation and Maintenance Manuals.

1. Operation and Maintenance Manuals shall be submitted in accordance with this Section and the Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Low-voltage electric motors shall be delivered, stored and handled in accordance with this Section, the Specifications, the motor manufacturer's instructions and the following:

1. Motors shall be inspected for shipping damage when received.

2. All sleeve or oil lubricated bearings motors shall be identified and the bearing reservoirs filled to normal level.

3. Motors shall be handled using motor base lifting lugs. Avoid pounding or bumping of motor which may damage motor. A hoist and spreader bar arrangement shall be used to avoid damage.

4. Motors shall be stored indoors in clean, dry heated areas.

5. Motor space heaters shall be energized to prevent moisture condensation throughout the storage and construction period.

6. Motors shall not be stored in areas subject to continuous vibration. A small quantity of grease shall be injected into each bearing on a monthly basis. Purged grease shall be inspected for water or rust. Motor shaft shall be rotated by hand to check for binding.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Spare Parts

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the low-voltage electric motors in accordance with this Section and the Specifications.

2. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

3. Spare parts shall be furnished in accordance with the manufacturer's recommendations for the motor size and type. Spare parts shall include at a minimum the following:

a. One complete set of bearing linings, or renewable ball or roller bearings shall be provided for each three (or less) of each type and size of motor. Spare bearings shall be furnished for all motor types. When sleeve bearing motors are provided, spare oil rings shall be furnished for those motors.

b. One set of brushes shall be provided for each DC type motor and wound rotor type motor requiring them.

c. One complete assembly of brush holders and supports shall be provided for each size of DC type motor and wound rotor type motor requiring them.

d. One complete assembly of collector rings shall be provided for each size of wound rotor type motor requiring them.

e. One complete set of fans and guards shall be provided (per each set of three or less) for each size totally enclosed fan cooled type motor.

f. One set of bearing temperature detectors shall be provided (per each set of three, or less) of each type of motor 250 horsepower and larger.

g. One set of upper and outer seal assemblies shall be provided (per each set of three or less) for each size submersible type motor.

h. One set of O ring kit shall be provided (per each set of three or less) for each size submersible type motor.

i. One set of wear rings shall be provided (per each set of three or less) for each size submersible type motor.

B. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the motors furnished under this section for a period of one year after acceptance. As a minimum, there shall be provided sufficient oil and grease to make a least one lubricant change for each motor as applicable.

2. Replace all lubricants used during startup and testing prior to acceptance of equipment. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Driven Equipment

1. The motor manufacturers are as shown on the Contract Drawings or stated in the Sections detailing the driven equipment, or approved equal if applicable..

2.02 MATERIALS / EQUIPMENT

A. Design Requirements

1. Motors shall be designed, built, and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL and NYCEC. The classifications, ratings, performance and testing of all motors shall be in accordance with the latest edition of NEMA MG1.
2. Motor winding shall be copper.
3. Motors shall be premium efficiency type and shall have nominal efficiencies in accordance with NEMA MG1. Motors with horsepower or rpm's not listed by NEMA shall conform to comparable standards of construction and materials as those for listed NEMA motors.
4. Motors shall be of sufficient capacity to operate the driven equipment under all conditions of operation without loading the motors beyond their rated nameplates current and power under all operating conditions imposed by the driven equipment.
5. The rating of the motors offered shall in no case be less than the horsepower shown on the Contract Drawings or stated in the Specifications. Both the rating and the characteristics of the motor shall be suitable for the successful operation of the driven equipment, under load conditions, within nameplates values of service factor and ambient temperatures.
6. Motors shall be of three phase construction for ratings above 1/3 horsepower and single phase construction for 1/3 horsepower or less.
7. Low-voltage motors shall be of a type approved for starting characteristics and ruggedness as may be required under the actual conditions of operation.
8. Low-voltage motors shall be designed for full voltage starting.
9. Reduced voltage starters, shall ensure that the motor develops ample torque and is able to accelerate and attain its operating speed under the load conditions imposed by the driven equipment.
10. Multi-speed motors shall have a separate winding for each speed unless.
11. Portable devices shall have totally enclosed motors and approved cord with provisions for grounding. They shall be suitable for the available power supply.
12. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient.
13. Motors shall comply with the EPAct 1992 and EISA 2007.
14. Variable-speed motors shall comply with NEMA MG1.
15. Variable-speed motors operated from variable frequency drives shall comply with NEMA MG1 and shall be inverter duty rated.

B. Single Phase Motors

1. Single phase motors shall be rated 115 or 230 volt, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment.
2. Bearings for single phase, open, enclosed and explosion-proof motors shall be grease lubricated ball type with grease fittings or with lubrication for 10 years of normal operation.
3. Motors shall be totally-enclosed except small fan motors may be open type if suitably protected from moisture, dripping water, and lint accumulation. Motor features shall be in accordance with the following:
    a. Open motors shall be split phase or capacitor start in accordance with torque requirements, 1.35 Service Factor, 40 degrees C Ambient Class B Insulation.
    b. Enclosed motors shall be capacitor start, fan cooled 1.15 service factor, 40 degrees C ambient, Class F, treated insulation. Enclosed motors shall be totally enclosed fan cooled, or non-ventilated. Enclosed motors shall be designed to withstand chemical corrosion and shall be severe duty type equipped with cast iron end shields, neoprene gaskets, stainless steel shaft, heavy pressed steel fan cover and provision for threaded conduit connection.
    c. Explosion-proof motors shall be fan cooled, split phase or capacitor start in accordance with torque requirements, 1.0 service factor, 40 degrees C ambient, equipped with swivel conduit connector and long leads for external connection.
    d. Direct drive fan motors shall be shaded pole or permanent split capacitor, 1.35 service factor, 40 degrees C ambient.

C. Three Phase Motors

1. General
    a. Three phase motors shall be squirrel cage induction type, copper wound, designed for operation on a 3 phase, 60 Hertz alternating current system.
    b. Three phase squirrel cage motors shall be severe duty and shall conform to the requirements of IEEE 841.
    c. Motor voltage shall be as shown on the Contract Drawings.
    d. Motors used with adjustable frequency controllers shall be as stated in this Section, the Specifications and the Contract Drawings.
    e. Unless otherwise required by the load, all motors shall be NEMA Design B, normal starting torque. Locked rotor KVA/HP shall not exceed NEMA Code Letter G for 20 HP motors and larger.

f. The design of the stator, rotor and shaft shall be in accordance with the approved practice of leading manufacturers. The motor frame shall be a rigid structure, designed to maintain the lamination in correct alignment and shall not be dependent on the lamination or bolts for rigidity.

g. Motors having considerable core length shall be provided with approved means for taking up shrinkage in length.

h. Motor rotors shall be of cast or fabricated aluminum or fabricated copper or copper alloy as required to meet the motor performance characteristics of slip, torque, and efficiency.

2. Bearings

a. Horizontal motors shall be provided with either the rolling element (anti-friction) or sliding element (sleeve) type bearings. Anti-friction type bearings shall be used for all NEMA frame motors. Where greater power and speeds are required by the driven equipment, sleeve type bearings shall be used. The bearings for all motors larger than 200 horsepower shall be insulated to prevent shaft currents and related bearing damage.

b. Bearings for 3 phase drip-proof, enclosed and explosion-proof motors shall be grease lubricated, ball type. Bearings shall be fitted with inlet fittings and outlet plugs. Motor bearings and grease reservoirs shall be protected from the entry of contaminants.

c. Bearings for direct drive fan motor shall be of the oil lubricated sleeve type.

d. When anti-friction bearings are furnished on horizontal motors for ratings to 500 horsepower and speeds to 3600 RPM they shall have a minimum bearing life of 100,000 hours as defined by AFBMA. Suitable fittings shall be provided to permit convenient positive purging of old grease during regreasing operation. Close running shaft seals shall prevent leakage of grease as well as prevent the entrance of foreign materials such as water and dirt into the bearing area. Motors equipped with anti-friction bearings shall have the appropriate AFBMA number stamped on a nameplate attached to the motor.

e. When furnished, sleeve bearings shall be ring-oiled with an adequate, integral self-cooled oil reservoir. The bearing sleeves shall be lined with a high tin content babbitt to minimize oil contamination. Close running shaft seals shall prevent oil leakage as well as prevent entrance of foreign material such as water and dirt into the bearing area. Oil level sight gages with permanently marked

easily discernible oil level shall be provided. In addition, inspection openings to observe the oil rings shall also be provided.

f. When required by motor speed and bearing size, provision shall be made for forced lubrication. The oil supply shall be supplied with motor. In addition, oil rings and an adequate oil reservoir in the bearing housings shall be provided to permit orderly shutdown of the motor in the event of failure of the formed feed lubrication system.

g. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected. The rated minimum life of the thrust bearings shall be at least 15,000 hours when operated at rated speed and full load thrust. The driven equipment manufacturer shall supply the motor manufacturer with the speed and thrust conditions required by the driven equipment.

h. Submersible motor bearings shall be permanently sealed and lubricated. Anti-friction guide and thrust bearings shall be replaceable. Bearings shall have a rated minimum life of 15,000 hours.

3. Insulation

a. The insulation system for three phase AC motors shall be rated Class F, with a service factor of 1.15 times the nameplate horsepower rating when operated on a sine wave supply and a service factor of 1.0 on an adjustable frequency supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with an ambient temperature not exceeding 40 degrees C.

b. Windings shall be epoxy coated. The windings shall be thoroughly treated with approved insulating compound suitable for protection against moisture, salt air and slightly acid or alkaline conditions. The insulation system for enclosed motors shall be upgraded by additional dips and bakes to increase moisture resistance.

c. Motors for outdoor service and all motors larger than 200 horsepower shall have vacuum/pressure impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in a temperature controlled oven.

d. Motors applied in speed varying service and operated from variable frequency controllers shall have an inverter grade insulation system designed and built in accordance with NEMA MG1 Part 31.

e. The stator windings and end turn connections shall be fully brazed to withstand full voltage starting regardless of the starting method

indicated in this Section, the Specifications and the Contract Drawings. The bracing system shall essentially eliminate coil vibration under the high current conditions of starting as well as during normal operation. If a tied system is used, it shall be such that no tie depends on the integrity of any other tie within the system.

f. Motors larger than 200 horsepower shall be form wound. Form wound coils with a micaceous ground wall insulation is required with additional insulation similar to Mica 5 and hot pressed to make a sealed system. Coils shall be form wound with mica insulation and each separate coil shall be vacuum pressure impregnated before inserting into slots.

4. Enclosures

a. Wound rotor motors shall be drip-proof, except for crane and hoist installations and where specified otherwise.

b. Motors shall have a steel or cast iron frame and a cast iron or steel conduit box. For wound rotor motors separate boxes for stator and rotor connections shall be provided. For NEMA frame size motors cast aluminum frames and terminal boxes may be used.

c. Motor enclosures shall conform to the NEMA classifications specified and to the following:

1) Open Drip proof: Motors shall have a steel or cast iron frame, cast iron end brackets and steel conduit box. Vertical motors of the open type shall be provided with drip hoods of approved shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing. Open motors shall be provided with corrosion resistant screens over the air openings in accordance with NEMA requirements for guarded machines.

2) Totally enclosed fan cooled and non-ventilated motors shall have a cast iron frame, cast iron end brackets and cast iron conduit box. Drain holes shall be provided on each end of motor.

3) Explosion proof motors shall have a cast iron frame, cast iron end brackets and cast iron conduit box. Explosion proof motors shall be UL listed for Class 1, Division 1, Group D hazardous areas.

4) Severe duty motors shall include a corrosion resistant treatment. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, stainless steel

"T" drains in both end brackets, corrosion resistant fan, and stainless steel hardware.

5) Submersible motors shall be hermetically sealed, watertight with tandem mechanical seals suitable for continuous submergence and listed for Class 1, Division 1, Group D locations.

d. Conduit Boxes

1) Motor conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Motor conduit box shall be in accordance with the following:

a) Conduit box shall be gasketed and shall include rubber-like gaskets between the frame and the conduit box and between the conduit box and its cover.

b) Conduit boxes or openings in motor housings shall be provided with conduit hub type fittings to permit threaded conduit connections. Single phase, explosion-proof and direct drive fan motors shall be provided with conduit fittings and leads to permit external connection.

c) Conduit box sizes shall be in accordance with code requirements. This shall include appropriate terminations for the rated voltages..

d) Protective and auxiliary devices, shall terminate in auxiliary conduit boxes..

e) Terminal leads shall be flexible and shall be of sufficient length to extend for a distance of not less than ten inches beyond the face of the terminal box. Terminal leads shall be fitted with solder less lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with a non-wicking, non-hygroscopic insulating material or an insulating "wrap-cap" as manufactured by Ideal Industries.

f) Provisions for terminal box size, length of leads, size of conduit openings and type of terminal lugs shall be complied with irrespective of any other standards or practice.

g) A motor frame grounding stud shall be provided inside the conduit box. A drilled and tapped hole shall be included.

D. DC Motors

1. General

a. DC motors shall be designed and built in accordance with NEMA Standard MG1-12 for use on a full wave, single phase, rectified power supply.

b. DC motors shall be heavy duty, industrial SCR drive type, direct current. Motor construction shall be shunt-wound or permanent-magnet type as stated in this Section, the Specifications and the Contract Drawings.

c. DC motors shall provide a constant torque output over the operating speed range, with fixed shunt excitation and variable DC armature voltage.

2. Bearings shall be grease lubricated, double shielded, with shaft seals.

3. Insulation

a. The insulation system for DC motors shall be Class F, with a service factor of 1.15 times the nameplate horsepower rating.

b. The windings shall be epoxy coated and include a thermostat protector. Thermostat shall be in accordance with the requirements specified under this Section.

4. Enclosures

a. DC motor enclosure shall be totally enclosed fan cooled, or non-ventilated. The frame size shall be selected by the manufacturer to prevent overheating when continuously operated at low speeds.

b. Motor enclosures shall be severe duty type, designed to withstand chemical corrosion, and shall utilize corrosion resistant materials for special finishes in their construction. Motors shall be equipped with cast iron end shield, neoprene gaskets, stainless steel shaft, heavy pressed steel fan cover and provisions for threaded conduit connection.

c. The motor enclosure shall be fitted with a factory mounted tachometer generator. The generator shall be C-face or flange mounted construction.

E. Accessories

1. General

a. Motor accessories shall be provided in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

2. Rotor Grounding

   a. An approved rotor grounding means or mechanism shall be provided to drain induced currents, parasitic and static charges to ground.

3. Space Heaters

   a. Each outdoor motor 5 horsepower and larger shall be provided with space heaters.

   b. Each motor 5 horsepower and larger enclosed motors installed indoors, in damp unheated spaces, shall also be provided with space heaters.

4. Each motor 250 horsepower and larger shall be provided with space heaters.

5. Space heaters for condensation prevention shall be rated 120 volt. Wattage shall be suitable for the particular frame size and type in accordance with the manufacturer's recommendation.

6. Space heater wire leads shall be brought out to an auxiliary conduit box on the motor. Box construction shall match main power conduit box.

F. Winding Protection

1. Winding Protective Devices:

   a. Thermostat type protection shall be provided for each motor in accordance with the following:

      1) Submersible motors and explosion proof motors.

      2) Variable speed motors up to 25 horsepower.

   b. Thermistor type protection shall be provided for each motor in accordance with the following:

      1) Constant speed motors 50 horsepower and larger up to 200 horsepower.

      2) Variable speed motors 30 horsepower and larger up to 200 horsepower.

   c. Resistance temperature detectors shall be 100 ohm precision type with calibrated resistance-temperature characteristics. Detectors, two per phase, shall be positioned to detect highest winding temperature and located between coil sides in stator slots. Detector leads shall be wired to a separate NEMA 4X terminal box.

2. Thermostats shall be bi-metal disk or rod type embedded in the stator windings. Thermostat contacts shall be automatic reset type, rated 120 volts AC, 5 amps minimum opening on excessive temperature.

3. Thermistors embedded in each stator phase winding shall be in direct contact with the winding conductors. Each thermistor circuit shall be factory wired to 120 volts solid state control module mounted at the motor in a NEMA 4X box. The control module contacts shall be automatic reset type, rated 120-volt AC, 5 amps minimum opening on excessive temperature.

G. Bearing Temperature Protection

a. Bearing temperature detectors, RTD type similar to the winding detectors specified under this Section shall be provided on each bearing for horizontal motors and on the thrust bearing for vertical motors.

b. Each motor 250 horsepower and larger shall be provided with stator and bearing temperature detectors.

H. Special Application

1. Cranes, elevators, hoists, and other devices complying with special safety codes shall be furnished complete with their control equipment, and with all accessories and safety devices for approved safe and efficient operation.

I. Single Phase Motors

1. Single phase motors requiring auxiliary starting resistors, capacitors or reactors and switching devices shall be furnished as combination units with such auxiliaries either incorporated within motor housings or housed in suitable enclosures, mounted upon motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. External Surfaces:

a. All severe duty motors shall have all external surfaces pretreated, primed and painted. External surfaces shall be pretreated so the surface is clean and free of contaminants. After pretreatment, the surface shall be primed with an oxide primer and then spray painted with a minimum of 0.003-inch-thick epoxy polyamide and semi-gloss coating that is chemical, solvent, salt water, and acid resistant.

b. All other motors shall have external surfaces pretreated, primed and painted in accordance with the manufacturer's standard treatment.

2. Internal Surfaces:

a. All severe duty motors shall have all internal surfaces pretreated, primed and painted. Internal surfaces shall be pretreated so the

surface is clean and free of contaminants. After pretreatment, the surface shall be primed with an oxide primer and then painted with an epoxy paint. Machined joints and threaded parts shall be coated with rust inhibiting compound.

b. All other motors shall have internal surfaces pretreated and primed in accordance with the manufacturer's standard treatment.

B. Hardware

1. All machined bolts and screws and other hardware shall be of the hex head type and shall be zinc plated.

2. Stainless steel hardware shall be used on severe duty motors.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the motors at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of IEEE 112 and NEMA MG1 and shall demonstrate that the equipment tested conforms to the requirements specified inclusive of the efficiency requirements stated in this Section.

2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

3. Every motor rated less than 200 horsepower shall be given a routine test at the manufacturer's factory. The routine test shall consist of:

a. No Load Speed, Voltage and Current at rated frequency.

b. Locked Rotor Current.

c. Winding Resistance.

d. High Potential.

e. Bearing Inspection.

f. Measurement of Secondary Volts at standstill for wound-rotor units.

4. Motors rated at 200 horsepower or greater shall be given complete initial tests consisting of:

a. Full-load Heat Run.

b. Percent Slip.

c. No Load Speed, Voltage, Current and losses at rated frequency.

d. Full Load Current.

e. Locked rotor Torque.

f. Locked-rotor Current.

g. Breakdown Torque (Calculated).

h. Starting Torque (squirrel-cage).

i. Winding Resistance.

j. High Potential.

k. Sound.

l. Vibration.

m. Efficiencies at 125, 100, 75 and 50 percent of full load.

n. Power Factors at 125, 100, 75 and 50 percent of full load.

o. Bearing Inspection.

p. Measurement of Secondary Volts at collector rings for wound-rotor units.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with this Section and the Specifications.

2. Motors shall be witness tested. Motors shall be given a complete test two weeks before and then retested in the presence of the witness.

3. When complete initial or witness tests are required for a group of the same type, rating and horsepower for the same application, all units of the group shall be subjected to the complete test, unless specifically stated otherwise in this Section or the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Motors

1. Motors shall be installed in accordance with manufacturer's instructions and recommendations.

2. Each motor shall be carefully and properly aligned with the driven equipment.

3. Equipment shall be secured to mounting surface with anchor bolts. Anchor bolts shall be provided meeting manufacturer's recommendations and of sufficient size and number to secure equipment.

4. Motor nameplates shall be installed for identification of equipment. Nameplates shall be provided in accordance with the requirements of Section 26 05 53 - Identification for Electrical Systems.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, motors shall be field tested for operation and conformance. The Contractor shall perform field tests in accordance with this Section, the Specifications and the Contract Drawings. The field tests shall be witnessed by the Engineer and certified by the Contractor.

2. Motor testing shall be performed by the manufacturer's representative, prior to energizing equipment.

3. Equipment shall not be energized without the permission of the Engineer.

4. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall include at a minimum the following:

   a. Motors shall be checked to determine that they have been properly installed, lubricated and connected.

   b. Motors shall be checked to determine they are not overloading, overheating or defective.

   c. Motors shall be checked to determine they comply with performance and design parameters.

A. Manufacturer's Field Services

1. A qualified manufacturer's service representative shall assist in the installation of the motors, check the motor installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the plant operations and maintenance staff in the care, operation and maintenance of the motors.

2. The Contractor shall provide equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings.

3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

4. The service representative shall sign in with the Engineer on each day they are at the site.

3.04 STARTUP / DEMONSTRATION

A. Acceptance Testing

1. The Contractor shall provide acceptance testing of the motors. All acceptance testing shall be performed by the testing firm, after the completion of the Field Tests specified under this Section. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

2. Acceptance inspection shall be performed on each motor larger than 200 horsepower. Inspection shall include the following:

   a. Electrical and grounding connections shall be inspected.

   b. Shaft alignment, proper mounting and lubrication shall be inspected.

   c. Ventilating air passageways shall be inspected for blockage.

   d. Excessive noise shall be inspected.

   e. Any overheating shall be inspected.

   f. Correct rotation shall be inspected.

   g. Protective detectors operation shall be checked.

   h. Any excessive vibration shall be checked.

   i. Space heater operation shall be checked.

3. Acceptance electrical testing shall be performed on each motor larger than 200 horsepower. Testing shall include the following:

   a. Insulation resistance tests shall be performed.

   b. Surge comparison testing shall be performed.

   c. Vibration tests shall be performed.

   d. Bearing insulation resistant tests on insulated bearings shall be performed.

   e. Running current and voltage shall be measured and evaluated relative to load conditions and nameplate full-load amperes.

   f. High-potential tests shall be performed.

   g. For wound rotor motors, additional electrical testing at minimum and normal operating load points and at ring short shall be performed.

   h. Motors shall be operated with driven equipment for a minimum of 48 continuous hours and rechecked for overheating and vibration.

4. All tests and values for AC and DC motors shall be in accordance with the manufacturer’s recommendations and NETA ATS.

5. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing medium-voltage electric motors. Medium-voltage electric motors shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 53 – Identification for Electrical Systems.

1.04 REFERENCES

A. Definitions

1. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at 1000 volts and below 99000 volts.

B. Reference Standards

1.	AFBMA Standard 9 Bearings.	-	Load Ratings and Fatigue Life for Ball
2.	AFBMA Standard 11	-	Load Ratings and Fatigue Life for Roller Bearings.
3.	API Standard 541	-	Form-Wound Squirrel-Cage Induction Motors 375 kW (500 HP) and Larger
4.	EPAct 1992	-	Energy Policy and Conservation Act of 1992
5.	EISA 2007	-	Energy Independence and Security Act of 2007
6.	IEEE 112	-	IEEE Standard Test Procedure for Polyphase Induction Testing Motors and Generators.
7.	IEEE 841	-	Premium-Efficiency, Severe Duty Totally Enclosed Fan- Cooled Squirrel-Cage Induction Motors.
8.	NEMA MG1	-	Motors and Generators.
9.	NEMA MG 10	-	Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors.
10.	NETA ATS	-	Acceptance Testing Specifications.
11.	NIST	-	US National Institute of Standards and Technology.
12.	NEC	-	National Electrical Code.
13.	NYCEC	-	New York City Electrical Code.
14.	NYC EPPR	-	New York City Environmentally Preferable Purchasing Rule.

1.05 DESCRIPTION

A. Motor Data

1. Motor data is specified under the Section of the Specification detailing the requirements of the driven equipment with which the motor is supplied. These data include voltage, rpm, HP, and enclosure types.

B. Motor Types

1. The motor types specified under this Section shall include:

a. Three Phase, alternating current, NEMA frame, squirrel cage, induction motors.

b. Three Phase, alternating current, above NEMA frame, squirrel cage, induction motors.

c. Three Phase, alternating current, wound-rotor, squirrel cage, induction motors.

1.06 QUALITY ASSURANCE

A. General:

1. Motors shall comply with the requirements of NYC EPPR.

2. The motor manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

3. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure each motor is designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings,

4. Motor manufacturer shall use a shop test facility that has calibrated testing apparatus, inclusive of a calibrated dynamometer and qualified experienced technicians for all shop tests. Calibration of all testing apparatus shall be within one year.

5. All test equipment, instrument calibration and test reports shall be in accordance with the latest edition of the accuracy standard of The U.S. NIST and NETA ATS.

6. Nameplates shall be provided for each motor. Nameplates shall clearly indicate information in accordance with NEMA requirements. Nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins.

B. Field Tests:

1. The motors shall be field tested.

2. Field testing shall be performed in accordance with the requirements specified under this Section and the Specifications.

3. Retain the services of the motor manufacturer for field service.

4. Field service shall be in accordance with the requirements specified under this Section and the Specifications.

5. For motors larger than 200 horsepower an independent testing firm shall be retained to perform acceptance testing of the motors.

   a. The testing firm shall have experience in the inspection and testing of motors and shall be a member company of NETA.

   b. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

   c. Acceptance testing shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Motors

B. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.

2. Motor Test Data Sheets shall be submitted. All values shall be from tests of previously manufactured, electrically duplicate motors or calculated data. Sheets shall be marked to indicate motor application location, manufacturer, type, frame size, bearing type, lubrication medium and enclosure type. Data Sheets shall at a minimum include:

   a. Winding resistances.

   b. Torques.

   c. Efficiencies.

   d. Power factors.

   e. Slip.

   f. Full load.

   g. Locked rotor and no-load amperes.

   h. Rotor voltage and amperes for wound rotor units.

   i. Nameplates temperature and results of dielectric tests.

3. An outline drawing or an outline data sheet showing complete motor dimensions shall be submitted to cover every motor. Several motors of the same type and rating for the same application may be covered by a single drawing or outline sheet. Drawings or sheets shall bear complete

identifying data including frame size, speed, horsepower ratings and application for each particular unit.

4. Description of proposed shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted in advance prior to conformation of witness testing dates and actual testing as follows:

   a. At least 60 days in advance for test locations in the US.

   b. At least 90 days in advance for test location outside of the US.

5. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 60 days in advance to actual testing, five recent references with phone numbers shall be submitted.

6. All motor accessories, heaters, detectors, etc., shall be submitted.

7. Bill of Materials for the proposed motors shall be submitted.

C. Certificates of Compliance:

1. Certified copies of motor characteristic curves and all other data necessary for establishing control and protective equipment settings shall be submitted.

2. Results of shop tests shall be certified. When routine tests are made in conjunction with complete initial tests, unwitnessed results shall be certified, and copies shall be submitted. Results shall be included for each test.

3. Data and results of witness tests shall be submitted with copies of certified initial tests, accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed and the Engineer shall be notified of the arrival date.

D. Reports:

1. Shop test and field test reports shall be submitted.

2. Manufacturer's site visit and acceptance testing reports shall be submitted.

E. Operation and Maintenance Manuals.

1. Operation and Maintenance Manuals shall be submitted in accordance with this Section and the Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Medium-voltage electric motors shall be delivered, stored, and handled in accordance with this Section, the Specifications, the motor manufacturer's instructions and the following:

1. Motors shall be inspected for shipping damage when received.
2. All sleeve or oil lubricated bearings motors shall be identified, and the bearing reservoirs filled to normal level.
3. Motors shall be handled using motor base lifting lugs. Avoid pounding or bumping of motor which may damage motor. A hoist and spreader bar arrangement shall be used to avoid damage.
4. Motors shall be stored indoors in clean, dry heated areas.
5. Motor space heaters shall be energized to prevent moisture condensation throughout the storage and construction period.
6. Motors shall not be stored in areas subject to continuous vibration. A small quantity of grease shall be injected into each bearing on a monthly basis. Purged grease shall be inspected for water or rust. Motor shaft shall be rotated by hand to check for binding.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Spare Parts

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the medium-voltage electric motors in accordance with this Section and the Specifications.
2. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.
3. Spare parts shall be furnished in accordance with the manufacturer's recommendations for the motor size and type. Spare parts shall include at a minimum the following:
    a. One complete set of bearing linings, or renewable ball or roller bearings shall be provided for each three (or less) of each type and size of motor. Spare bearings shall be furnished for all motor types. When sleeve bearing motors are provided, spare oil rings shall be furnished for those motors.
    b. One complete assembly of collector rings shall be provided for each size of wound rotor type motor requiring them.
    c. One complete set of fans and guards shall be provided (per each set of three or less) for each size totally enclosed fan cooled type motor.
    d. One set of bearing temperature detectors shall be provided (per each set of three, or less) of each type of motor 250 horsepower and larger.

B. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the motors furnished under this section for a period of one year after acceptance. As a minimum, there shall be provided sufficient oil and grease to make a least one lubricant change for each motor as applicable.

2. Replace all lubricants used during startup and testing prior to acceptance of equipment. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Driven Equipment

1. The motor manufacturers are as shown on the Contract Drawings or stated in the Sections detailing the driven equipment, or approved equal if applicable.

2.02 MATERIALS / EQUIPMENT

A. Design Requirements

1. Motors shall be designed, built, and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, UL and NEC. The classifications, ratings, performance and testing of all motors shall be in accordance with the latest edition of NEMA MG1.

2. Motor winding shall be copper.

3. Motors shall be premium efficiency type and shall have nominal efficiencies in accordance with NEMA MG1. Motors with horsepower or rpm's not listed by NEMA shall conform to comparable standards of construction and materials as those for listed NEMA motors.

4. Motors shall be of sufficient capacity to operate the driven equipment under all conditions of operation without loading the motors beyond their rated nameplates current and power under all operating conditions imposed by the driven equipment.

5. The rating of the motors offered shall in no case be less than the horsepower shown on the Contract Drawings or stated in the Specifications. Both the rating and the characteristics of the motor shall be suitable for the successful

operation of the driven equipment, under load conditions, within nameplates values of service factor and ambient temperatures.

6. Motors shall be of three phase construction for all ratings. Medium -voltage motors shall be of a type approved for starting characteristics and ruggedness as may be required under the actual conditions of operation.

7. Medium-voltage motors shall be designed for full voltage starting.

8. Reduced voltage starters, shall ensure that the motor develops ample torque and is able to accelerate and attain its operating speed under the load conditions imposed by the driven equipment.

9. Multi-speed motors shall have a separate winding for each speed.

10. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient.

11. Motors shall comply with the EPAct 1992 and EISA 2007.

12. Variable-speed motors shall comply with NEMA MG1.

13. Variable-speed motors operated from variable frequency drives shall comply with NEMA MG1 and shall be inverter duty rated.

B. Three Phase Motors

1. General

a. Three phase motors shall be squirrel cage induction type, copper wound, designed for operation on a 3 phase, 60 hertz alternating current system.

b. Three phase squirrel cage motors shall be severe duty and shall conform to the requirements of IEEE 841.

c. Motor voltage shall be as shown on the Contract Drawings.

d. Motors used with adjustable frequency controllers shall be as stated in this Section, the Specifications, and the Contract Drawings.

e. Unless otherwise required by the load, all motors shall be NEMA Design B, normal starting torque. Locked rotor KVA/HP shall not exceed NEMA Code Letter G.

f. The design of the stator, rotor and shaft shall be in accordance with the approved practice of leading manufacturers. The motor frame shall be a rigid structure, designed to maintain the lamination in correct alignment and shall not be dependent on the lamination or bolts for rigidity.

g. Motors having considerable core length shall be provided with approved means for taking up shrinkage in length.

h. Motor rotors shall be of cast or fabricated aluminum or fabricated copper or copper alloy as required to meet the motor performance characteristics of slip, torque, and efficiency.

2. Bearings

a. Horizontal motors shall be provided with either the rolling element (anti-friction) or sliding element (sleeve) type bearings. Anti-friction type bearings shall be used for all NEMA frame motors. Where greater power and speeds are required by the driven equipment, sleeve type bearings shall be used. The bearings for all motors larger than 200 horsepower shall be insulated to prevent shaft currents and related bearing damage.

b. Bearings for 3 phase drip-proof, enclosed and explosion-proof motors shall be grease lubricated, ball type. Bearings shall be fitted with inlet fittings and outlet plugs. Motor bearings and grease reservoirs shall be protected from the entry of contaminants.

c. When anti-friction bearings are furnished on horizontal motors for ratings to 500 horsepower and speeds to 3600 RPM, they shall have a minimum bearing life of 100,000 hours as defined by AFBMA. Suitable fittings shall be provided to permit convenient positive purging of old grease during regreasing operation. Close running shaft seals shall prevent leakage of grease as well as prevent the entrance of foreign materials such as water and dirt into the bearing area. Motors equipped with anti-friction bearings shall have the appropriate AFBMA number stamped on a nameplate attached to the motor.

d. When furnished, sleeve bearings shall be ring-oiled with an adequate, integral self-cooled oil reservoir. The bearing sleeves shall be lined with a high tin content babbitt to minimize oil contamination. Close running shaft seals shall prevent oil leakage as well as prevent entrance of foreign material such as water and dirt into the bearing area. Oil level sight gages with permanently marked easily discernible oil level shall be provided. In addition, inspection openings to observe the oil rings shall also be provided.

e. When required by motor speed and bearing size, provision shall be made for forced lubrication. The oil supply shall be supplied with motor. In addition, oil rings and an adequate oil reservoir in the bearing housings shall be provided to permit orderly shutdown of the motor in the event of failure of the formed feed lubrication system.

f. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected. The rated minimum life

of the thrust bearings shall be at least 15,000 hours when operated at rated speed and full load thrust. The driven equipment manufacturer shall supply the motor manufacturer with the speed and thrust conditions required by the driven equipment.

3. Insulation

   a. The insulation system for three phase AC motors shall be rated Class F, with a service factor of 1.15 times the nameplate horsepower rating when operated on a sine wave supply and a service factor of 1.0 on an adjustable frequency supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with an ambient temperature not exceeding 40 degrees C.

   b. Windings shall be epoxy coated. The windings shall be thoroughly treated with approved insulating compound suitable for protection against moisture, salt air and slightly acid or alkaline conditions. The insulation system for enclosed motors shall be upgraded by additional dips and bakes to increase moisture resistance.

   c. Motors for outdoor service and all motors larger than 200 horsepower shall have vacuum/pressure impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in a temperature-controlled oven.

   d. Motors applied in speed varying service and operated from variable frequency controllers shall have an inverter grade insulation system designed and built-in accordance with NEMA MG1 Part 31.

   e. The stator windings and end turn connections shall be fully brazed to withstand full voltage starting regardless of the starting method indicated in this Section, the Specifications, and the Contract Drawings. The bracing system shall essentially eliminate coil vibration under the high current conditions of starting as well as during normal operation. If a tied system is used, it shall be such that no tie depends on the integrity of any other tie within the system.

   f. All motors shall be form wound. Form wound coils with a micaceous ground wall insulation is required with additional insulation similar to Mica 5 and hot pressed to make a sealed system. Coils shall be form wound with mica insulation and each separate coil shall be vacuum pressure impregnated before inserting into slots.

4. Enclosures

   a. Wound rotor motors shall be drip-proof, except for crane and hoist installations and where specified otherwise.

b. Motors shall have a steel or cast-iron frame and a cast iron or steel conduit box. For wound rotor motors separate boxes for stator and rotor connections shall be provided. For NEMA frame size motors cast aluminum frames and terminal boxes may be used.

c. Motor enclosures shall conform to the NEMA classifications specified and to the following:

1) Open Drip proof: Motors shall have a steel or cast-iron frame, cast iron end brackets and steel conduit box. Vertical motors of the open type shall be provided with drip hoods of approved shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing. Open motors shall be provided with corrosion resistant screens over the air openings in accordance with NEMA requirements for guarded machines.

2) Totally enclosed fan cooled, and non-ventilated motors shall have a cast iron frame, cast iron end brackets and cast-iron conduit box. Drain holes shall be provided on each end of motor.

3) Explosion proof motors shall have a cast iron frame, cast iron end brackets and cast-iron conduit box. Explosion proof motors shall be UL listed for Class 1, Division 1, Group D hazardous areas.

4) Severe duty motors shall include a corrosion resistant treatment. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, stainless steel "T" drains in both end brackets, corrosion resistant fan, and stainless-steel hardware.

5) Submersible motors shall be hermetically sealed, watertight with tandem mechanical seals suitable for continuous submergence and listed for Class 1, Division 1, Group D locations.

d. Conduit Boxes

1) Motor conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Motor conduit box shall be in accordance with the following:

a) Conduit box shall be gasketed and shall include rubber-like gaskets between the frame and the conduit box and between the conduit box and its cover.

b) Conduit boxes or openings in motor housings shall be provided with conduit hub type fittings to permit threaded conduit connections. Conduit box sizes shall be in accordance with code requirements. This shall include medium-voltage terminations or stress cones.

c) Protective and auxiliary devices, shall terminate in separate auxiliary conduit boxes.

d) Terminal leads shall be flexible and shall be of sufficient length to extend for a distance of not less than ten inches beyond the face of the terminal box. Terminal leads shall be fitted with solder less lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with a non-wicking, non-hygroscopic insulating material.

e) Provisions for terminal box size, length of leads, size of conduit openings and type of terminal lugs shall be complied with irrespective of any other standards or practice.

f) A motor frame grounding stud shall be provided inside the conduit box. A drilled and tapped hole shall be included.

5. Enclosures

a. Motor enclosures shall be severe duty type, designed to withstand chemical corrosion, and shall utilize corrosion resistant materials for special finishes in their construction. Motors shall be equipped with cast iron end shield, neoprene gaskets, stainless steel shaft, heavy pressed steel fan cover and provisions for threaded conduit connection.

b. The motor enclosure shall be fitted with a factory mounted tachometer generator. The generator shall be C-face or flange mounted construction.

C. Accessories

1. General

a. Motor accessories shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

2. Rotor Grounding

a. An approved rotor grounding means or mechanism shall be provided to drain induced currents, parasitic and static charges to ground.

3. Space Heaters

a. Each motor shall be provided with space heaters.

b. Space heaters for condensation prevention shall be rated 120 volts. Wattage shall be suitable for the particular frame size and type in accordance with the manufacturer's recommendation.

c. Space heater wire leads shall be brought out to an auxiliary conduit box on the motor. Box construction shall match main power conduit box.

D. Winding Protection

1. Resistance Temperature Detector (RTD):

a. RTDs shall be provided for each motor in accordance with the following:

1) RTDs shall be 100-ohm precision type with calibrated resistance-temperature characteristics.

2) Detectors, two per phase, shall be positioned to detect highest winding temperature and located between coil sides in stator slots.

3) Detector leads shall be wired to a separate auxiliary terminal box.

E. Bearing Temperature Protection

1. RTD Bearing Sensors

a. Bearing temperature detectors, RTD type similar to the winding detectors specified under this Section shall be provided on each bearing for horizontal motors and on the thrust bearing for vertical motors.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. External Surfaces:

a. All severe duty motors shall have all external surfaces pretreated, primed, and painted. External surfaces shall be pretreated so the surface is clean and free of contaminants. After pretreatment, the surface shall be primed with an oxide primer and then spray painted with a minimum of 0.003-inch thick epoxy polyamide and semi-gloss coating that is chemical, solvent, salt water, and acid resistant.

b. All other motors shall have external surfaces pretreated, primed, and painted in accordance with the manufacturer's standard treatment.

2. Internal Surfaces:

a. All severe duty motors shall have all internal surfaces pretreated, primed, and painted. Internal surfaces shall be pretreated so the surface is clean and free of contaminants. After pretreatment, the surface shall be primed with an oxide primer and then painted with an epoxy paint. Machined joints and threaded parts shall be coated with rust inhibiting compound.

b. All other motors shall have internal surfaces pretreated and primed in accordance with the manufacturer's standard treatment.

B. Hardware

1. All machined bolts and screws and other hardware shall be of the hex head type and shall be zinc plated.

2. Stainless steel hardware shall be used on severe duty motors.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the motors at the manufacturer's plant prior to shipment. Shop test shall be in accordance with the latest revisions of IEEE 112 and NEMA MG1 and shall demonstrate that the equipment tested conforms to the requirements specified inclusive of the efficiency requirements stated in this Section.

2. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

3. All motors shall be given complete initial tests consisting of:

a. Full-load Heat Run.

b. Percent Slip.

c. No Load Speed, Voltage, Current and losses at rated frequency.

d. Full Load Current.

e. Locked rotor Torque.

f. Locked-rotor Current.

g. Breakdown Torque (Calculated).

h. Starting Torque (squirrel-cage).

i. Winding Resistance.

j. High Potential.

k. Sound.

l. Vibration.

m. Efficiencies at 125, 100, 75 and 50 percent of full load.

n. Power Factors at 125, 100, 75 and 50 percent of full load.

o. Bearing Inspection.

p. Measurement of Secondary Volts at collector rings for wound-rotor units.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with this Section and the Specifications.

2. All motors shall be witness tested. Motors shall be given a complete test two weeks before and then retested in the presence of the witness.

3. When complete initial or witness tests are required for a group of the same type, rating and horsepower for the same application, all units of the group shall be subjected to the complete test.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Motors

1. Motors shall be installed in accordance with manufacturer's instructions and recommendations.

2. Each motor shall be carefully and properly aligned with the driven equipment.

3. Equipment shall be secured to mounting surface with anchor bolts. Anchor bolts shall be provided meeting manufacturer's recommendations and of sufficient size and number to secure equipment.

4. Motor nameplates shall be installed for identification of equipment. Nameplates shall be provided in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, motors shall be field tested for operation and conformance. The Contractor shall perform field tests in accordance with this Section, the Specifications, and the Contract Drawings. The field tests shall be witnessed by the Engineer and certified by the Contractor.
2. Motor testing shall be performed by the manufacturer's representative, prior to energizing equipment.
3. Equipment shall not be energized without the permission of the Engineer.
4. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall include at a minimum the following:
    a. Motors shall be checked to determine that they have been properly installed, lubricated, and connected.
    b. Motors shall be checked to determine they are not overloading, overheating or defective.
    c. Motors shall be checked to determine they comply with performance and design parameters.

A. Manufacturer's Field Services

1. A qualified manufacturer's service representative shall assist in the installation of the motors, check the motor installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the plant operations and maintenance staff in the care, operation, and maintenance of the motors.
2. The Contractor shall provide equipment start-up services and training in accordance with this Section, the Specifications, and the Contract Drawings.
3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.
4. The service representative shall sign in with the Engineer on each day they are at the site.

3.04 STARTUP / DEMONSTRATION

A. Acceptance Testing

1. The Contractor shall provide acceptance testing of the motors. All acceptance testing shall be performed by the testing firm, after the completion of the Field Tests specified under this Section. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

2. Acceptance inspection shall be performed on each motor. Inspection shall include the following:
   a. Electrical and grounding connections shall be inspected.
   b. Shaft alignment, proper mounting and lubrication shall be inspected.
   c. Ventilating air passageways shall be inspected for blockage.
   d. Excessive noise shall be inspected.
   e. Any overheating shall be inspected.
   f. Correct rotation shall be inspected.
   g. Protective detectors operation shall be checked.
   h. Any excessive vibration shall be checked.
   i. Space heater operation shall be checked.
3. Acceptance electrical testing shall be performed on each motor. Testing shall include the following:
   a. Insulation resistance tests shall be performed.
   b. Surge comparison testing shall be performed.
   c. Vibration tests shall be performed.
   d. Bearing insulation resistance tests on insulated bearings shall be performed.
   e. Running current and voltage shall be measured and evaluated relative to load conditions and nameplate full-load amperes.
   f. High-potential tests shall be performed.
   g. For wound rotor motors, additional electrical testing at minimum and normal operating load points and at ring short shall be performed.
   h. Motors shall be operated with driven equipment for a minimum of 48 continuous hours and rechecked for overheating and vibration.
4. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.
5. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SECTION 26 06 11 – CABLE AND CONDUIT SCHEDULE
CONTRACT KENS-EAST - 2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install wires, cables, and conduit complete and operational.

B. All wiring, cable and conduit shall be furnished and installed under this Contract, unless specifically noted otherwise.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 – General Electrical Requirements.

B. Section 26 05 14 – Medium-Voltage Cables and Accessories.

C. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories.

D. Section 26 05 27 – Grounding.

E. Section 26 05 33 – Raceways and Boxes for Electrical Systems.

F. Section 26 05 43 – Underground Duct, Manholes and Raceways for Electrical Systems.

G. Section 26 05 53 – Identification for Electrical Systems.

H. Section 26 08 11 – General Electrical Testing.

1.04 REFERENCES

A. Definitions

1. Conduit shall include all types of raceways provided under this Contract.

2. Install or Installed, as applicable to Conduit, shall mean install all Conduit, raceways, fittings, boxes, and accessories required to achieve a complete and functional conduit system.

3. Install or Installed, as applicable to Conduit, shall also include cleaning and swabbing, grounding, and bonding of the conduit system and the provision of drag lines in each conduit on completion of the conduit system.

4. Installed or Installed, as applicable to wire and cable, shall mean the pulling in of wires or cable, testing wire or cable insulation resistance, continuity and absence from grounds as well as terminating of all conductors and testing for proper connection.

B. Reference Standards

1. Reference standards shall be those in the Sections listed in Article 1.03 - Related Sections.

2. NEC - National Electrical Code

1.05 DESCRIPTION

A. Wire, Cable and Conduit Schedule, attached at the end of this Section, lists the following information:

1. Conduit Number

2. Conduit Size

3. Material type of conduit

4. Point of origination

5. Point of termination

6. Enclosed wire or cable size and the number and types

7. Purpose of the wire or cable contained in the conduit such as power, control, ground, etc.

8. Miscellaneous information.

B. The Conduit numbering system consists of two parts separated by a hyphen.

1. The first part is the equipment identification number.

2. The second part is the individual conduit identification number which may be presented.

C. In general, the Wire, Cable and Conduit Schedules do not indicate lighting and receptacle circuits, as well as some other wire, cable, and conduit to be provided under this Contract.

D. Cable and Conduit Schedules are shown in the Contract Drawings. Not all conduits, cables, and wires are shown in the Schedules. Contractor is responsible to furnish and install the complete electrical conduit/cable system in order to make the system work satisfactory.

E. The Contractor shall refer to the Specifications and Contract Drawings for additional wire, cable, and Conduit requirements.

1.06 QUALITY ASSURANCE

A. Conform to the requirements specified in the Sections listed in Article 1.03 - Related Sections.

B. All Conduits shall contain a separate equipment grounding conductor sized according to the NYCEC.

1.07 SUBMITTALS

A. Cable and Conduit Schedules shall be submitted for approval.

B. Cable and Conduit Schedules shall show all the details of all wires, cables, and conduit to be installed under this Contract, including at a minimum the following information on each Conduit run:

1. Conduit Number

2. Conduit Size

3. Material type of conduit

4. Point of origination

5. Point of termination

6. Enclosed wire or cable size and the number and types

7. Purpose of the wire or cable contained in the conduit such as power, control, ground etc.

8. Miscellaneous information.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Electrical testing shall be provided in accordance with this Section, the Specifications, and the Contract Drawings.

1. The Contractor shall provide all labor, materials, tools, instruments, power, and all services necessary to provide the tests specified for all electrical materials, equipment and systems provided under this Contract.

2. The Contractor shall engage the services of an Independent Testing Company (ITC) to perform specific tests as detailed in this Section and the Specifications.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 – General Electrical Requirements

B. Section 26 05 27 – Grounding

C. Section 25 05 29 – Hangers and Supports for Electrical Systems

D. Section 26 05 53 – Labelling and Identification.

E. Section 26 05 73 – Power System Studies.

F. Section 26 05 75 – Shock Hazard and Arc Flash Studies.

1.04 REFERENCES

A. Definitions

1. Plant refers to facilities used for the processing and conveyance of water or wastewater and includes pump stations, water and wastewater processing or treatment facilities.

2. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

3. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at above 1000 volts and below 99000 volts.

4. All references to the Electric Utility or Utility shall mean Consolidated Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

1.	NETA ATS	-	Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
2.	NEC	-	National Electrical Code.
3.	Infraspection Institute	-	Standard for Infrared Inspection of Electrical Systems and Rotating Equipment.
4.	US NIST Technology	-	US National Institute of Standards and

1.05 DESCRIPTION

A. Upon completion of the electrical installation, the Contractor shall perform tests to demonstrate that the entire electrical system is in proper working condition and is in accordance with the Contract Drawings and the Specifications.

1. Tests shall be as outlined in this Section and those of the individual Sections.

2. Field tests shall be in addition to the factory tests on individual items previously performed at the manufacturer's plant.

3. Perform insulation integrity tests and ground resistance tests before operating tests.

4. Determine proper rotation of motors before permanent connections are made.

1.06 QUALITY ASSURANCE

A. ITCs conducting Electrical Testing shall

a. Have a minimum of ten (10) years conducting tests as detailed in NETA, ATS.

b. Be a first-tier Subcontractor.

c. Be a firm independent of any parties to the Contract or associated Contract such as a Subcontractor or other Contractor.

d. Be a firm independent of the Engineer or the Designer.

e. Be a NETA Accredited Company deploying NETA certified personnel.

B. ITCs conducting Thermographic Testing shall

a. Have a minimum of ten (10) years conducting tests as detailed by the Infraspection Institute.

b. Be a first-tier Subcontractor.

c. Be a firm independent of any parties to the Contract or associated Contract such as a Subcontractor or other Contractor.

d. Be a firm independent of the Engineer or the Designer.

e. Deploys Infraspection Institute certified personnel.

C. Calibration of Equipment

1. All test instruments and test equipment shall have been calibrated within the 12-month period immediately preceding the dates when they will be used on this Contract.

2. All test instruments and test equipment shall bear the calibration marks, stamps or seals of an approved testing body or agency with reference standards directly traceable to those held by the US National Institute of Standards and Technology (NIST).

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Organization of the Testing Companies inclusive of details of the specific personnel that will be utilized on specific tests.
2. Documentation detailing firm accreditation
3. Qualifications of testing personnel
4. Proposed testing methods and schedules, test setup and sample data sheets
5. Calibration Reports of test equipment
6. All field test reports

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Factory Tests

1. Factory and witnessed shop testing requirements shall be as detailed in the individual equipment Sections.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Schedules/Scheduling

1. Written notice of the intent to proceed with any scheduled and approved tests shall be given to the Engineer at least two (2) weeks in advance of the commencement of the testing.
2. When testing requires that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the

Engineer for review and approval forty-five (45) days prior to the two (2) weeks' notice above.

3. When testing has been scheduled as above, the Shaft Superintendent must be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment.

4. All testing that requires temporary shutdown of Shaft equipment must be coordinated with Shaft Superintendent so as not to affect proper Shaft operations.

5. At the end of each workday, all equipment shall be back in place and ready for immediate use should a shaft emergency arise.

6. In addition, should an emergency condition occur during testing, at the request of either the Shaft Superintendent or the Engineer or the Engineer's designated representative attending the testing, the equipment shall be placed back in service immediately and turned over to Shaft.

7. In the event of accidental shutdown of equipment, the Contractor shall notify Shaft Superintendent or the Engineer or the Engineer's designated representative immediately to allow for an orderly restart of affected equipment.

3.02 IMPLEMENTATION

A. Test Personnel/Test Equipment

1. The Contractor shall furnish all instruments and qualified personnel for all tests.

2. The Contractor and where applicable in conjunction with the ITC, shall furnish all instruments and qualified personnel for all tests.

B. Attendance at Tests

1. All tests shall be made in the presence of the Engineer or a duly authorized representative of the Engineer.

2. A manufacturer's representative in accordance with the requirements of the specific equipment Section shall be present at all equipment tests.

3. When the presence of the Engineer or the Engineer's representative is waived, sworn statements, in duplicate, of the tests made and the results thereof shall be furnished to the Engineer by the Contractor.

4. A manufacturer' representative.

C. Tests/Testing by Others

1. The Electrical Contractor shall make available, the electrical system and personnel when required by other Contractors to test their respective equipment.

2. The Electrical Contractor shall coordinate their resources with the other Contractors.

3.03 FIELD TESTING / QUALITY CONTROL

A. Non ITC Testing

1. The Contractor shall complete all testing not required to be completed by an ITC including:

a. All low-voltage equipment testing.

b. All raceway testing not requiring the use of medium-voltage test methods.

c. All low-voltage cable testing utilizing low-voltage or extra-low voltage methods.

d. All phasing verifications utilizing low-voltage or extra-low voltage methods.

e. All continuity testing utilizing low-voltage or extra-low voltage methods.

f. All ground system bonding and continuity testing utilizing low-voltage or extra-low voltage methods.

g. All low-voltage voltage and potential testing and verifications.

B. ITC Testing

1. An independent testing company comprised of NETA certified test personnel and project administrators shall be retained by the Contractor to complete the following:

a. All medium-voltage equipment testing.

b. All medium-voltage cable testing

c. All dielectric tests

d. All low-voltage and medium-voltage protective device testing and setting related to Arc Flash Studies

e. All low-voltage and medium-voltage Protective Device calibration, testing

f. All potential and current transformer Testing and determination of performance curves.

g. All Primary and Secondary injection tests of protective device systems.

h. All ground systems testing.

2. Thermographic Testing and Imaging

a. An independent testing company comprised of Infraspeciton Institute certified test personnel and project administrators shall be retained by the Contractor to complete the following:

1) All thermographic testing of electrical equipment.

2) As required by specific Sections.

b. The level of plant loading of equipment subject to Thermographic Testing shall be as specified in the equipment Section but shall not be less than sixty (60) percent of the rated equipment load.

C. Final Field Testing

1. The Contractor shall complete the installation and testing of the electrical installation at least two (2) months prior to the startup and testing of all other Work of the Contract.

2. During the period between the completion of electrical installation and the startup and testing of all other Work, the Contractor shall make all completed and serviceable components of the electrical installation available to the other Contractors for their use in performing Preliminary and Final Field Tests.

3. Before each test commences, the Contractor shall submit a detailed test procedure and provide manpower and scheduling for the approval of the Engineer.

4. The Contractor shall furnish detailed test procedures for any of their equipment required as part of the field tests of systems by other Contractors.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Unit Substations. Unit substations shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The substations required under this section shall be the secondary unit type.

C. The substation shall consist of the following major equipment as minimum:

1. Medium-Voltage Switchgear
2. Medium-Voltage Cast Coil Transformers
3. Low-Voltage Switchgear

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

C. Section 26 05 53 – Identification for Electrical Systems

D. Section 26 05 73 – Power System Studies.

E. Section 26 05 75 – Shock Hazard and Arc Flash Studies.

F. Section 26 13 26 – Medium-Voltage Metal-Clad Switchgear.

G. Section 26 23 23 – Low-Voltage Switchgear.

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility or Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volt and within the 600 VAC Class.

4. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 volts and below 99,000 volts.

B. Reference Standards

C. Substations shall comply with the latest applicable provisions and recommendations of the following:

1. IEEE C37.13 - Low-Voltage AC Power Circuit Breakers Used in Enclosures.

2. IEEE C37.16 - Preferred Ratings. Related Requirements, and Application Recommendations for Low-Voltage AC (635 VAC and below) and DC (3200 DC and below) Power Circuit Breakers.

3. IEEE C37.20.1 - Metal-Enclosed Low-Voltage (1000 VAC and below and 3200 VDC and below) Power Circuit Breaker Switchgear.

4. IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers

5.	IEEE C57.12.51	-	Guide for the Interchangeability of Ventilated Dry-Type Power Transformers.
6.	IEEE C57.12.91	-	Test Code for Dry-Type Distribution and Power Transformer.
7.	IEEE C57.94	-	Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type Distribution and Power Transformers.
8.	NYSBC	-	New York State Building Codes.
9.	NEMA TR1	-	Transformers, Step-Voltage Regulators, and Reactors.
10.	NETA ATS	-	NETA, Acceptance Testing Specifications.
11.	NESC	-	National Electrical Safety Code.
12.	NEC	-	National Electrical Code.
13.	NYCEC	-	New York City Electrical Code.
14.	Con-Ed, EO-2022	-	Con Edison High-tension Service Specification.
15.	NIST	-	National Institute of Standards and Technology.

1.05 DESCRIPTION

A. Each substation shall be a matched integrated type arranged in double-ended fashion, consisting of the following:

1. Two Medium-voltage switchgear sections
2. Two Medium Voltage Transformer sections and
3. Two secondary Low-voltage Switchgear sections.

B. The arrangement of each substation shall be as shown on the Contract Drawings.

1.06 QUALITY ASSURANCE

A. General

1. Substations shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, NFPA, and the NEC.
2. The Contractor is responsible to submit all applicable drawings for the required approvals including the local government DOB and the Utility.
3. The costs of the substation drawing submission and any resubmissions shall be included for payment in the lump sum price bid for the Work under this Contract.

4. Each substation section shall be separated from the others by steel barriers but electrically connected and physically joined to form a single, metal-enclosed structure arranged to form a continuous lineup.

5. Each substation shall be arranged in segments. The arrangement of each substation segment shall be as shown on the Contract Drawings.

6. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated, and finished with ANSI No. 61 indoor light grey paint.

7. The substation manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one year.

8. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. NIST and NETA ATS.

B. Seismic Requirements

1. The substation shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

C. Field Tests:

1. The substation shall be field tested. Field testing shall be performed in accordance with the requirements specified under this Section.

2. The services of the substation manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under this Section.

3. Retain the service of an independent testing firm who shall perform field acceptance testing of the substation. The testing firm shall have experience in the inspection and testing of substation equipment and shall be a member company of NETA. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under this Section.

D. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's technical information, which shall include:

a. Dimensional and weight information.

b. Single-line diagrams

c. Three-line diagrams.

d. Technical specifications.

e. Catalog cuts.

f. Construction details of enclosures.

2. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least ninety (90) days in advance prior to conformation of witness testing dates and actual testing.

3. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 90 days in advance to actual testing, five (5) recent references with phone numbers shall be submitted.

4. Substation anchorage details with design calculations signed by NYS Licensed Engineer.

B. Certificates of Compliance:

1. Seismic qualification certification from the manufacturer including mounting recommendations.

2. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

C. Reports:

1. Shop test and field test reports shall be submitted.

2. Manufacturer's site visit and acceptance testing reports shall be submitted.

D. Bill of Materials

E. Operation and maintenance

1. Operation and Maintenance manuals shall be submitted in accordance with this Section and the Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Substation equipment shall be delivered, stored, and handled in accordance with this Section, the Specifications, the manufacturer's instructions and the following.

1. Substation equipment shall be inspected for shipping damage or loose parts when received.

2. Evidence of water which may have entered equipment during transit shall be checked.

3. Substation equipment shall be lifted, rolled, or jacked into locations shown on the Contract Drawings.

4. Switchgear shall be handled and placed in position without circuit breakers.

5. Substation equipment shall be stored in a clean, dry location in which a uniform temperature is maintained.

6. Substation equipment shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.

7. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the substations in accordance with this Section and the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations.

D. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance.

a. Replace all lubricants used during start-up and testing prior to acceptance of equipment.

b. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

1. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Substation equipment shall be as manufactured by:

1. Schneider Electric, Andover, MA.
2. ABB, New Berlin, Wisconsin.
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Medium-Voltage Switchgear

1. The Medium-voltage switchgear sections shall be a metal-enclosed, dead front, free standing structures, each containing an air interrupter switch.
2. Medium-voltage switchgear shall conform to Section 26 13 26 – Medium-Voltage Metal-Clad Switchgear.
3. The air interrupter switch shall be in accordance with the following:
   a. Switch shall be manually operated stored-energy, gang-operated, quick make quick break type, with separate main and arcing contacts and arc quenching chambers.
   b. The speed of the Switch opening and closing shall be independent of operator action.
   c. Switch shall be three pole, load breaking with the continuous current rating in amperes and the fault-close and momentary rating.
   d. Switch voltage ratings shall be as follows:
      1) 15 kV, 95 kV BIL.
   e. Switch shall include interlocks in accordance with the following:
      1) Switch shall be prevented from closing with the switch compartment door not fully closed and latched.
      2) Switch compartment door shall be prevented from opening when the switch is closed.
      3) Operation of air interrupter switch shall be prevented with secondary load connected to the transformer.
4. Switch enclosure shall be grounded steel.
5. The switch enclosure shall have a sight window for visual inspection of switch contacts.
6. The switch enclosure shall be provided with lightning arrestors, distribution class, and 2-hole copper compression connectors.

7. The switch enclosure shall have high voltage signs in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems

B. Transformers

1. The transformers shall be solid cast-coil, dry-type construction designed for, 3 phase, 60 Hertz, with delta connected primary, wye connected secondary with the neutral brought out through a bushing.
2. Transformers shall have an impedance of 5.75 percent and an efficiency of 98 percent minimum.
3. Transformer kVA capacity and primary and secondary voltages shall be as shown on the Contract Drawings.
4. Transformers shall be in NEMA 12 enclosure.
5. BIL Rating shall be as follows:
   a. 15 kV windings – 95 kV.
   b. Low-voltage windings - 10 kV.
6. Transformer winding construction shall be in accordance with the following:
   a. Epoxy resin shall be rated 185 degrees C used throughout the construction.
   b. Winding temperature rise shall not exceed 80 degrees C above 40 degrees C ambient.
   c. Cores shall be silicon steel construction assembled and rigidly clasped to ensure mechanical strength and to reduce vibration.
   d. Core shall be grounded to the frame with a flexible grounding strap.
   e. Windings shall be copper and have high dielectric and mechanical strength insulation.
   f. Coils shall be sized, insulated, and supported for short circuit forces and be impervious to moisture.
   g. The windings shall withstand impulse, induced, and dielectric test voltage and short circuit testing without damage.
   h. The high voltage primary windings shall be disc wound for enhanced voltage stress distribution and to facilitate complete epoxy penetration.
   i. The high voltage primary windings shall be completely impregnated and cast in epoxy resin under vacuum in molds and be oven cured.
   j. The Low-voltage secondary winding shall be resin encapsulated by winding epoxy-impregnated insulation. All exposed surfaces shall

be covered and sealed with epoxy. The entire winding shall be oven cured.

7. Transformers shall be equipped with six 2-1/2 percent fully rated taps. Taps shall include two-2-1/2 percent primary taps above normal and four-2-1/2 percent primary taps below normal.

8. Easily accessible bolted tap links in the high-voltage windings shall permit the changing of taps only when the transformer is de-energized.

9. Transformer enclosure shall be grounded heavy gauge sheet steel. The transformer enclosure shall include ventilation louvers, removable panels for access to taps, mechanical lugs, and vibration isolating pads.

10. Each transformer enclosure shall be equipped with a diagrammatic nameplate showing details of the winding configuration, tap connections and voltages.

11. Transformers shall be equipped with forced air-cooling equipment. Transformer components shall be suitable for the forced air rating.

12. Forced air cooling equipment shall be provided.

13. The forced air-cooling equipment shall increase the transformers output rating by 33.33 percent without modification to the transformer core and windings and shall include:

    a. Cooling fans shall provide air cooling of windings.

    b. Temperature probes embedded in the windings shall provide sensing of temperature.

    c. Fused control power transformer shall provide supply for cooling fans and control unit.

    d. Electronic control unit with digital display shall provide monitoring and control of the transformers. The control shall permit manual and automatic operation of the fans and temperature readings of the windings.

    e. Hardware necessary for mounting air-cooling equipment shall be provided within the transformer enclosure.

14. The transformer enclosure shall have high voltage signs in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems.

C. Low-Voltage Switchgear

1. The Low-voltage switchgear shall consist of individually mounted power circuit breakers in draw out type construction and auxiliary transition compartments and shall comply with Section 26 23 23 – Low-Voltage Switchgear.

D. Insulating Floor Mat

1. The Contractor shall furnish and install non-conductive floor mat in front of the switchgear to provide insulation for the workers.

2. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. All metal surfaces of the substation/s shall be thoroughly cleaned and given one coat of zinc chromate primer.

2. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose lacquer enamel.

3. All exterior surfaces shall be given three coats of the same lacquer. The color of the exterior finishing coats shall be light gray ANSI No. 61.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the substations at the manufacturer's plant prior to shipment.

2. Shop test shall be in accordance with the latest revisions of IEEE and ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.

3. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

4. Switchgear shop tests shall include the following:

a. Physical inspection shall be performed including torque tests of bus bolts.

b. Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.

c. Continuity test shall be performed on power and control wires.

d. Functional operations test which shall include pick up, dropout, time delay, sequence, and polarity.

e. Primary hi-potential tests shall be performed. Primary current carrying parts shall be tested between phases, phase to ground, and line to load. The applied voltage shall be twice rated voltage plus 1000V for 1 minute.

f. Hi-Potential tests on control and secondary wiring shall be performed. Control circuit wiring shall be tested for 1500 volts to ground for one (1) minute.

g. Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation. Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

5. Transformer shop tests shall include the following:

a. Resistance measurements of all windings shall be performed on the rated voltage connection.

b. Ratio test on the rated voltage connection and on all tap, connections shall be performed.

c. Polarity and phase relation tests on the rated voltage connection shall be performed.

d. No load loss at rated voltage on the rated voltage connection shall be performed.

e. Excitation current at rated voltage on the rated voltage connection shall be performed.

f. Impedance and load loss at rated current on the rated voltage connection shall be performed.

g. Applied potential tests shall be performed.

h. Induced potential test shall be performed.

i. High potential test shall be performed.

j. Temperature rise test at both AA and FA ratings shall be performed.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests

3. For the Witnessed Shop Test, the Contractor shall perform all of the Certified Tests in the presence of the witnesses.

4. For Witnesses Shop Tests the Substation shall be fully assembled. Jumpering of shipping splits is not acceptable.

5. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

6. Substations shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Substation equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. Substation equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Substation equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

D. Steel channels shall be provided for support of substation equipment.

E. Substation equipment shall be securely mounted to mounting surface with anchor bolts.

F. Anchor substation to satisfy the specified seismic requirements in accordance with the anchorage details.

G. Install nameplates for identification of substation equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, substations shall be field tested for operation and conformance.

B. The Contractor shall perform field tests in accordance with this Section and Specifications.

C. The field tests shall be witnessed by the Engineer and certified by the Contractor.

D. Substations testing shall be performed by the manufacturer's representative, prior to energizing equipment.

E. Equipment shall not be energized without the permission of the Engineer.

F. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:

1. Device settings and adjustments shall be verified.

2. Mechanical and electrical interlocks shall be inspected, and controls shall be checked for proper operation.

3. Functional tests verifying the operations of all controls and displays.

G. Manufacturer’s Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the substations, check the substations installation before it is placed into operation, assist in the performance of field tests, observe, and

assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the substations.

2. The Contractor shall provide substation equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

   a. Minimum number of manufacturer's representative site visits per unit substations:

Visit Type	Minimum No. of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation & Inspection	1	3	5
Field Tests	1	3	3
Acceptance Testing	1	3	3
Training	1	2	2

3. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

4. The Engineer shall have the right to reallocate any unused person-days.

5. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

6. The service representative shall sign in and out with the Engineer on each day they are at the site. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide substation start-up services and Training in accordance with this Section and the Specifications.

B. Acceptance Testing

1. The Contractor shall provide acceptance testing of the substation.

2. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.

3. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

4. Acceptance testing inspection shall be performed on each substation. Inspection shall include the following:

   a. Physical, electrical, and mechanical condition shall be inspected.

   b. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

   c. All connections shall be inspected for high resistance.

   d. Electrical and mechanical interlock systems shall be checked for proper operation.

   e. Switch arc chutes, blade alignment and arc interrupter operation shall be checked.

   f. Insulators shall be inspected for evidence of damage or contamination.

   g. Equipment shall be cleaned and lubricated as required.

5. Acceptance electrical testing shall be performed on each substation. Testing shall include the following:

   a. Ground-resistance tests shall be performed.

   b. Insulation-resistance tests shall be performed on each bus section, on each switch, transformer and circuit breaker, phase-to-phase, and phase-to-ground.

   c. An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

   d. Contact-resistance test shall be performed.

   e. Control and metering wiring performance test shall be performed.

   f. Circuit breaker trip characteristics shall be determined by primary current injection.

6. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.

7. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Service Entrance Medium-Voltage, Cast-Coil Transformers with all auxiliary equipment as shown on the Contract Drawings, specified under this Section, and the Specifications.

B. The Service Entrance Transformers required under this section shall have the cast-coil transformers.

C. The Service Entrance Cast-Coil Transformers shall consist of the following major equipment as minimum:

1. Service Entrance Medium-Voltage Isolation Transformers

2. Neutral Grounding Resistor

D. The following index of this Section is presented for convenience:

E.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting.

B. Section 26 05 27 – Grounding.

C. Section 26 05 53 – Identification for Electrical Systems.

D. Section 26 05 73 – Power System Studies.

E. Section 26 13 11 – Service Entrance Switchgears (SES)

F. Section 26 13 26 – Medium-Voltage Metal-Clad Switchgear.

G. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

H. Section 26 05 75 – Shock Hazard and Arc Flash Studies.

I. Section 26 08 11 - General Electrical Testing

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility or Utility is Con Edison.

3. Low-voltage (LV) as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volt and within the 600 VAC Class.

4. Medium-voltage (MV) as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 volts and below 99,000 volts.

B. Reference Standards

C. SES and Transformer shall comply with the latest applicable provisions and recommendations of the following:

1. IEEE C57.12.01 - Standard General requirement for Dry Type Distribution and Power transformers including those with Solid Cast or Resin-Encapsulated Windings.

2.	IEEE C57.12.50	-	Requirements for Ventilated Dry-Type Distribution Transformers, 1–500 kVA Single-Phase and 15–500 kVA Three-Phase
3.	IEEE C57.12.51	-	Requirements for Ventilated Dry-Type Power Transformers, 501 kVA and larger Three-Phase, with High Voltage 601–34,500 Volts, Low Voltage 208Y/120–4,160 Volts.
4.	IEEE C57.12.55	-	Conformance Standard for Transformers—Dry-Type Transformers Used in Unit Installations, including Unit Substations.
5.	IEEE C57.12.55	-	Conformance Standard for Transformers—Dry-Type Transformers Used in Unit Installations, including Unit Substations.
6.	IEEE C57.12.70	-	Terminal Markings and Connections for Distribution and Power Transformers.
7.	IEEE C57.12.80	-	Standard Terminology for Power and Distribution Transformers.
8.	IEEE C57.12.91	-	Test Code for Dry-Type Distribution and Power Transformers.
9.	IEEE C57.96	-	Guide for Loading Dry-Type Distribution and Power Transformers.
10.	IEEE C57.124	-	Recommended Practice for the Detection of Partial Discharges and the Measurement of Apparent Charge in Dry-Type Transformers.
11.	UL 1561	-	Standard for Dry-Type General Purpose and Power Transformers
12.	NEMA	-	National Electrical Manufacturer Association
13.	NEMA TR1	-	Transformers, Step-Voltage Regulators, and Reactors.
14.	NETA ATS	-	NETA, Acceptance Testing Specifications.
15.	NESC	-	National Electrical Safety Code.
16.	NEC	-	National Electrical Code.
17.	NYCEC	-	New York City Electrical Code.
18.	Con -Ed, EO-2022-		Con Edison High-tension Service Specification.
19.	NIST	-	National Institute of Standards and Technology.

1.05 DESCRIPTION

A. Each Service Entrance Transformer shall consisting of the following:

1. Two cast-coil 13.2kV/13.2kV transformers
2. Protective devices and gauges
3. Cooling Fans
4. Neutral Grounding Resistors

B. The arrangement of each Service Entrance Transformer shall be as shown on the Contract Drawings.

C. The Contractor shall review installation procedures under other sections and contracts and coordinate them with the work specified herein.

1.06 QUALITY ASSURANCE

A. The Cast-Coil transformer manufacturer shall be the manufacturer of all the major components within the transformer assembly.

B. The manufacturer of the transformer equipment shall have produced Medium-voltage cast-coil transformer for minimum period of the last continuous fifteen (15) years.

1. The Contractor shall provide list of at least five (5) installations with similar equipment, to that which will provided under this contract, and demonstrating compliance with these requirements.
2. The Contractor will provide the name, address, telephone number and email of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning and operation of the equipment at the above listed five installations.

C. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Certified copy of the manufacturer's Design Tests made in accordance with IEEE standard and conducted on transformer models and type that is being offered for this contract.
2. Certified dimensioned outline drawings showing equipment layouts, front view and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.
4. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.
5. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.
6. Erection drawings.
7. Elementary Diagrams and Interconnecting Wiring Diagrams having their terminals identified and indicating the internal wiring and all control and test switch developments.
    a. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable.
    b. Separate drawings for each equipment/compartment shall be supplied.
    c. Wire lists in lieu of wiring diagrams shall not be acceptable.
8. Separate drawings for each compartment shall be supplied including individual compartment point-to-point wiring diagram.
9. Complete three-line diagrams detailing connections for all instrument transformers, relays, etc.
10. Complete Bill of Material.
11. Details of special features.
12. Manufacturer published time-current curves.
13. Instruction manuals of all protective relays for the equipment.
14. Current and potential transformer data, curves, and burden calculations for each CT and PT circuit.
15. Nameplate schedules.

16. Recommended spare parts list with pricing.
17. List of Special Tools.
18. Painting Procedures.
19. List of recommended lubricants.
20. Preliminary Operation and Maintenance manuals.
21. Finalized Operation and Maintenance manuals.
22. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the manufacturer satisfies qualifications stated in this Section.
    b. Seismic qualification certification from the manufacturer including mounting recommendations.
    c. Cybersecurity Equipment Certification
23. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least ninety (90) days in advance prior to conformation of witness testing dates and actual testing.
24. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least ninety (90) days in advance to actual testing, five (5) recent references with phone numbers shall be submitted.
25. Reports.
    a. All shop test and field test reports.
    b. All manufacturer's site visit and acceptance testing reports.
26. The Contractor shall coordinate with and submit the product submittal to Utility for their review and approval before furnishing and installation.
27. Transformer anchorage details with design calculations signed and sealed by NYS licensed Engineer.
28. The Contractor shall hire a NYS Registered Licensed P.E. to submit the application to the local government Electrical Plan Review Group. The Contractor shall be responsible for coordinating with the local government, Electrical Plan Review Group, paying all required fees. The Contractor shall be responsible to provide short-circuit and power system coordination study signed and sealed by a NYS Registered Licensed Professional Engineer to local government. Contractor shall be responsible to submit all applicable

drawings for the required approvals including approval required by the local government, Electrical Plan Review Group, and the Electric Utility.

29. The Contractor is responsible to submit all applicable drawings for the required approvals including the local government, NYS Building Codes and the Utility.

30. The costs of the Service Entrance Transformer drawing submission and any resubmissions shall be included for payment in the lump sum price bid for the Work under this Contract.

B. Seismic Requirements

1. The Transformer shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

2. The transformers shall be designed, constructed, and installed suitable for earthquake regulation in accordance with the seismic requirements of the New York State Building Codes and the Uniform Building Code.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The cast-coil transformer shall be delivered, stored, and handled in accordance with this Section, the Specifications, the manufacturer's instructions, and the following.

1. The transformer shall be inspected for shipping damage or loose parts when received.

2. Evidence of water which may have entered equipment during transit shall be checked.

3. Transformer shall be lifted, rolled, or jacked into locations shown on the Contract Drawings.

4. Transformer shall be stored in a clean, dry location in which a uniform temperature is maintained.

5. Transformer shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.

6. Where dampness or condensation may be encountered, heaters shall be provided for the Transformer to prevent moisture damage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts, special tools and supplies for the Service Entrance Transformer in accordance with this Section and the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished in accordance with the manufacturer's recommendations.

D. Spare parts for each Service Entrance Transformer shall include at a minimum, the following:

1. Two (2) complete cooling fans with motors.

2. One (1) protective relay device and gauge of each type provided.

E. Furnish the following tools:

1. All tools necessary to service, disassemble, repair, and adjust the equipment.

2. Any manufacturer specific special tool, not normally found in an electrician’s toolbox shall be furnished.

F. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance.

a. Replace all lubricants used during start-up and testing prior to acceptance of equipment.

b. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

1. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. MV Cast-Coil Transformer shall be as manufactured by:

1. Schneider Electric,

2. ABB,

3. Or approved equal.

B. Neutral Grounding Resistor shall be as manufactured by:

1. Schneider Electric,

2. Post Glover,

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Medium-Voltage Cast Coil Transformers

1. The transformers shall be solid-cast dry-type construction designed for, 3 phase, 60 Hertz, with delta connected primary, wye connected secondary with the neutral brought out through a bushing

2. The transformer shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, ANSI, NEMA, UL, NFPA, Utility Standard Specification (EO-2022) and the NEC.

3. The transformer shall be arranged in segments. The arrangement of the transformer segment shall be as shown on the Contract Drawings.

4. Transformer kVA capacity and primary and secondary voltages shall be as shown on the Contract Drawings.

5. The Transformer Rating shall be as follows:

a.	Winding Temperature Rise	80ºC
b.	BIL Rating	95 kV
c.	Minimum Efficiency	99%
d.	Impedance	5.75%
e.	Enclosure	NEMA 3R

6. Transformer winding construction shall be in accordance with the following:

a. Epoxy resin shall be rated 185 degrees C used throughout the construction.

b. Winding temperature rise shall not exceed 80 degrees C above 40 degrees C ambient.

c. Cores shall be silicon steel construction assembled and rigidly clasped to ensure mechanical strength and to reduce vibration.

d. Core shall be grounded to the frame with a flexible grounding strap.

e. Windings shall be copper and have high dielectric and mechanical strength insulation.

f. Coils shall be sized, insulated and supported for short circuit forces and be impervious to moisture.

g. The windings shall withstand impulse, induced and dielectric test voltage and short circuit testing without damage.

h. The high voltage primary windings shall be disc wound for enhanced voltage stress distribution and to facilitate complete epoxy penetration.

i. The high voltage primary windings shall be completely impregnated and cast in epoxy resin under vacuum in molds and be oven cured.

j. The Low-voltage secondary winding shall be resin encapsulated by winding epoxy-impregnated insulation. All exposed surfaces shall be covered and sealed with epoxy. The entire winding shall be oven cured.

k. For enhanced environmental protection and improved withstand ability to thermal shock and short-circuit stresses, the primary and secondary coil assemblies shall be of cast coil design. Each cast coil shall be cast under vacuum in a mold to assure complete, void-free epoxy resin impregnation throughout the entire insulation system.

l. The temperature monitor and fan control shall include at a minimum of the following digital readout,

1) GREEN - Power ON,

2) AMBER - Fan ON,

3) RED - High Temperature;

4) Audible high temperature alarm with alarm silence push button;

5) Maximum temperature memory with read and reset switch;

6) Auto/manual fan control switch,

7) System test switch;

8) Temperature sensing in all three (3) secondary coils.

9) Auxiliary alarm contact and means for remote control and temperature monitoring shall be provided.

10) Control power shall be provided from a separate, external control power source.

m. The electrical insulation system shall utilize class F material in a fully rated 185°C system. Transformer design temperature rise shall be based on a 30°C average ambient over a 24-hour period with a maximum of 40°C. Solid insulation in the transformer shall consist of inorganic materials such as glass fiber, electrical grade epoxy and

Nomex. All insulating materials must be rated for continuous 185°C duty.

n. The average temperature rise of the transformer windings shall not exceed 80°C when the transformer is operated at full nameplate rating. The transformers shall be capable of carrying 100% of nameplate kVA rating in a 40°C maximum 30°C average ambient as defined by ANSI C57.12.01.

o. The transformer shall be supplied in a knockdown case design, for ease in fitting through limited openings, and shall be of heavy gauge sheet steel construction, equipped with removable panels for access to the core and coils. Front and rear panels shall incorporate ventilating grills.

p. The transformer shall be designed to meet the sound level standards for dry transformers as defined in NEMA TRl and specified by IEEE Standard C57.12.10 for the applicable kVA size of dry-type transformer.

q. The outdoor cast-coil transformers are shown on the Contract Drawings, they shall include thermostatically controlled space heaters fed from external source which remains energized when the transformer is de-energized. Provide special ventilating grills that restrict the passage of rain or spray providing the degree of weather protection of a NEMA 3R enclosure.

r. Utility approved dry type transformers shall have primary and secondary coils vacuum cast in epoxy resin, utilizing step-lap mitered cruciform core construction.

7. Transformers shall be equipped with six 2-1/2 percent fully rated taps. Taps shall include two-2-1/2 percent primary taps above normal and four-2-1/2 percent primary taps below normal.

8. Easily accessible bolted tap links in the high-voltage windings shall permit the changing of taps only when the transformer is de-energized.

9. Transformer enclosure shall be grounded heavy gauge sheet steel. The transformer enclosure shall include ventilation louvers, removable panels for access to taps, and vibration isolating pads.

10. Each transformer enclosure shall be equipped with a diagrammatic nameplate showing details of the winding configuration, tap connections and voltages.

11. Transformers shall be equipped with forced air-cooling equipment. Transformer components shall be suitable for the forced air rating.

12. The forced air-cooling equipment shall increase the transformers output rating by 33.33 percent without modification to the transformer core and windings and shall include:
    a. Cooling fans shall provide air cooling of windings.
    b. Temperature probes embedded in the windings shall provide sensing of temperature.
    c. Fused control power transformer shall provide supply for cooling fans and control unit.
    d. Electronic control unit with digital display shall provide monitoring and control of the transformers. The control shall permit manual and automatic operation of the fans and temperature readings of the windings.
    e. Hardware necessary for mounting air-cooling equipment shall be provided within the transformer enclosure.
13. Service power transformers shall conform to the latest applicable IEEE, ANSI, and the Utility latest standards.
14. Transformers shall be Transient Voltage Resistance Transformer (TVRT) type to provide the protection against switching surge.
15. Equipment BIL ratings shall be without the use of surge arresters.
16. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated, and finished with ANSI outdoor rated light grey paint.
17. Terminal Compartment
    a. Transformer terminations section shall be side-wall mounted for terminations within air-filled terminal chambers on both primary and secondary side for cable entrance and exit.
    b. The transformer unit supplied shall include high voltage and low voltage terminal compartments. Connections to and from the transformer shall be by cable and terminations shall be made in the terminal compartments.
    c. The control and auxiliary power circuits shall be completely wired to a NEMA 4X stainless steel enclosure. Enclosure shall have hinged door and shall house all terminal blocks, auxiliary relays, cooling fan controls, etc.
18. Controls

a. The manufacturer shall furnish and install all relays, cooling fan controls, gauges, current transformers, etc. and all related wiring as shown on the Contract Drawings, specified herein and as required for proper operation.

b. All control and auxiliary wiring shall be #10 AWG minimum and shall be terminated in the control enclosure described in 2.02.E above. Cables and wires shall be routed in rigid steel conduit. Provide flexible conduit where required.

c. All wiring terminations shall be identified by legible markings on the device terminals. In addition, all wiring terminations shall be identified by permanent wiring jacket or wiring sleeves. Adhesive wire labels are not permitted. Each relay, fuse block, terminal block or other auxiliary device shall be permanently labeled to coincide with shop drawings, using 1"x 2" lamicoid nameplates.

d. The controls shall have all the remote contacts required for interconnection to switchgear, as shown on the Contract Drawings. All contacts shall be wired to terminal strips within the control enclosure, per ANSI C57.12.70.

19. Transformer Accessories

a. Transformer features and accessories shall include at a minimum:

1) Removable case for access to high-voltage strap-type connector taps for de-energized tap changing.

2) Provisions for lifting and provisions for jacking.

3) Two (2) ground pads.

B. Neutral Grounding Resistors (NGR)

1. Neutral ground resistors shall be provided for neutral grounding of each power transformer as shown on the Contract Drawings.

2. NGR shall comply with latest NEMA, NEC, ANSI, IEEE Standard 32, UL listed and the requirements listed below.

3. The resistor elements, shall be made from high resistance stainless steel edgewound helix strip wound around a ceramic core on a longitudinal stainless-steel bar.

4. The elements shall be individually supported on ceramic insulators designed for 15kV service. All elements of the grounding resistor shall be completely interconnected at the factory.

5. Resistor elements are joined by stainless steel connectors, connections shall be welded in place, to form a positive electrical path.

6. Ground and neutral bushings shall be provided together with clamp type terminals.

7. The frame assembly shall be constructed of corrosion-free aluminum structural angles with suitable clips for anchor bolts. An aluminum safety screen enclosure shall be provided which shall enclose all live parts of the resistor. All assembly hardware shall be corrosion resistant.

8. The resistors shall be mounted on the transformer pads and shall have the following ratings:

a.	Rated Current	400 Amps
b.	Rated Time	10 Seconds
c.	Rated Voltage	8000 Volts (Line-to-Neutral)
d.	Type	Dry, Metallic
e.	Temperature Rise	760° C

9. The grounding resistors shall be complete with the following accessories:

   a. Stand-off insulators, entrance bushings and terminals lugs with current transformer.

   b. Stainless steel NEMA 3R enclosure for totally enclosing the components with access door.

10. The above ratings shall be modified, if required, based on the short circuit and relay coordination study, as described in Section 26 05 73 - Power System Studies.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. Painting shall be in accordance with Section 09 91 90 – Painting.

2. All internal and external metal surfaces of the transformer shall be thoroughly cleaned, rinsed and phosphatized prior to painting.

3. The transformer shall be painted with a thermosetting electrostatically applied polyester powder with final baked on average thickness between 1.5 to 2.0 mils.

4. The color of all interior finishing coats shall be white.

5. The color of the exterior finishing coats shall be ANSI No. 61 grey.

6. The finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass ASTM B117 5% salt spray test for a minimum of 1000 hours.

7. A supply of touch-up paint shall be provided from paint used for the final coat.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. The Service Entrance Transformer manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one (1) year.

2. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. NIST and NETA ATS.

3. Shop testing shall be performed on the transformers at the manufacturer's plant prior to shipment.

4. Shop test shall be in accordance with the latest revisions of IEEE and ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.

5. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

6. Transformer shop tests shall include at minimum the following test:

a. Resistance measurements of all windings shall be performed on the rated voltage connection and all taps.

b. Ratio test on the rated voltage connection and on all tap connections shall be performed.

c. Polarity and phase relation tests on the rated voltage connection shall be performed.

d. No load loss at rated voltage on the rated voltage connection shall be performed.

e. Excitation current at rated voltage on the rated voltage connection shall be performed.

f. Impedance and load loss at rated current on the rated voltage connection shall be performed.

g. Applied potential tests shall be performed.

h. Induced potential test shall be performed.

i. High potential test shall be performed.

j. Temperature rise test at both AA and FA ratings shall be performed.

k. Temperature rise tests shall be perform on each transformer at the 80 °C rating in accordance with ANSI. This test shall be performed on the transformer prior to impulse tests. Temperature test(s) shall be made on each transformer. Transformer is supplied with auxiliary cooling equipment to provide more than one kVA rating, temperature test as listed above shall be made on the lowest kVA, AA rating and the highest kVA FA rating.

l. Impulse Test.

m. Operational test on auxiliary devices and wiring.

n. Insulation test on auxiliary devices and wiring.

o. Sound test

7. Test equipment to demonstrate that it has been properly assembled, properly lubricated, is not overheating, is not overloading, and has no electrical or mechanical defects.

8. Perform all certified shop test and submit the shop test reports prior to scheduling the witness shop test.

9. Contractor shall submit certificate of calibration of all test equipment.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests

3. The Witnessed Shop Test shall not be scheduled before the approval of the testing procedures and test stand layout

4. For the Witnessed Shop Test, the Contractor shall perform all of the Certified Tests in the presence of the witnesses.

5. For the Witnesses Shop Test, the transformer shall be fully assembled. Jumpering of shipping splits is not acceptable.

6. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

7. Transformer shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. The transformer shall be installed in accordance with manufacturer's instructions and recommendations.

B. The transformer shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. The transformer shall be installed on concrete pads at locations shown on the Contract Drawings.

D. Steel channels shall be provided for support of the transformer.

E. The transformer shall be securely mounted to mounting surface with anchor bolts.

F. Anchor transformer to satisfy the specified seismic requirements in accordance with the anchorage details.

G. Install nameplates for identification of transformer.

H. The Contractor shall follow manufacturer's instructions as to lifting requirements and attachment to structure.

I. The Contractor shall wire all equipment per Contract Drawings and as required.

J. The Contractor shall test and adjust all protection required for the transformer. All devices shall be properly adjusted such that all protection and control circuits operate correctly and safely.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, Service Entrance Transformers shall be field tested for operation and conformance.

2. The Contractor shall perform field tests in accordance with this Section and Specifications and Utility standard.

3. The field tests shall be witnessed by the Engineer, Utility Engineer, and certified by the Contractor.

4. Service Entrance Transformers testing shall be performed by the manufacturer's representative, prior to energizing equipment.

5. Equipment shall not be energized without the permission of the Engineer and Utility.

6. Prior to energization, the Contractor shall perform all test require by Utility and shall consist at a minimum of the following:
    a. The Contractor shall perform a service equipment Acceptance Test and submit the results to the Utility and Engineer for review and approval.
    b. The Contractor shall require to perform the certified relay testing and submit their results to the Utility and Engineer for review and approval.
    c. All required testing shall be performed by firms certified by InterNational Electrical Testing Association (NETA) to perform the testing.
    d. Transformers shall be subject to a high potential proof test at the field. The transformer manufacturer's recommended values shall be used for the proof tests.
7. The Contractor shall allow the Utility to perform all required tests on the combined (Utility/Customer) primary service feeder cables and switchgear terminations in conformance with the latest revision of Company Specification EO-4019
8. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:
    a. Device settings and adjustments shall be verified.
    b. Mechanical and electrical interlocks shall be inspected, and controls shall be checked for proper operation.
    c. Functional tests verifying the operations of all controls and displays.

B. Manufacturer's Field Services
1. The services of the transformer manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under this Section.
2. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the transformer, check the transformer installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the substations.

3. The Contractor shall provide equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

   a. Minimum number of manufacturer's representative site visits per unit substations:

Visit Type	Minimum Number of Visit(s)	Min. Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation and Inspection	1	3	5
Field Tests	1	3	3
Acceptance Testing	1	3	3
Training	1	2	2

4. The Engineer shall have the right to reallocate any unused person-days.

5. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

6. The service representative shall sign in and out with the Engineer on each day they are at the site. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site

C. The Contractor shall engage the services of an independent testing firm, as described in Section 26 05 73 - Power System Studies, to set all protective relays and devices based on the short circuit and relay coordination study.

D. After installation of the equipment, controls and all appurtenances, field test the equipment for system operation and conformance to the specified performance parameters.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide transformer start-up services and Training in accordance with this Section and the Specifications.

B. Acceptance Testing

1. The Contractor shall provide acceptance testing of the transformer.

2. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.

3. Retain the service of an independent testing firm who shall perform field acceptance testing of the transformer. The testing firm shall have experience in the inspection and testing of transformer and shall be a member of NETA. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer. Acceptance testing shall be in accordance with the requirements specified under this Section and Utility standard.
4. The acceptance testing shall be witnessed by the Engineer, Utility Engineer and certified by the Contractor.
5. Acceptance testing inspection shall be performed on each transformer. Inspection shall include the following:
    a. Physical, electrical, and mechanical condition shall be inspected.
    b. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.
    c. All connections shall be inspected for high resistance.
    d. Electrical and mechanical interlock systems shall be checked for proper operation.
    e. Cooling system and arc interrupter operation shall be checked.
    f. Insulators shall be inspected for evidence of damage or contamination.
    g. Equipment shall be cleaned and lubricated as required.
6. Acceptance electrical testing shall be performed on each transformer. Testing shall include the following:
    a. Ground-resistance tests shall be performed.
    b. Insulation-resistance tests shall be performed on each bus section, on each transformer, phase-to-phase, and phase-to-ground.
    c. An over potential test shall be performed on each bus section, each phase-to-ground Test each pole with other poles grounded.
    d. Contact-resistance test shall be performed.
    e. Control and metering wiring performance test shall be performed.
7. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.
8. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place into satisfactory operation Medium-voltage, metal-clad, Service Entrance Switchgear (SES) complete with all auxiliary equipment as shown on the Contract Drawings and specified in this Section.

B. The switchgear shall be suitable for application to Service Switchgear, 15kV, 3-phase, 3-wire, 60 Hz systems.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 26 05 11 – General Electrical Requirements.

C. Section 26 05 27 - Grounding

D. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems

E. Section 26 05 53 – Identification for Electrical Systems

F. Section 26 05 73 – Power System Studies.

G. Section 26 05 75 – Shock Hazard and Arc Flash.

H. Section 26 08 11 – General Electrical Testing.

I. Section 26 33 23 – Central Battery Equipment.

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 VAC and within the 600 VAC Class.

4. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 VAC and below 99,000 VAC.

B. Reference Standards

1.	IEEE C37.010	-	Application Guide for AC High-Voltage Circuit Breakers (>1000VAC) Rated on a Symmetrical Current Basis.
2.	IEEE C37.04	-	Rating Structure for AC High-Voltage Circuit Breakers.
3.	IEEE C37.06	-	AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000V.
4.	IEEE C37.09	-	Test Procedure for AC High-Voltage Circuit Breakers with Rated Maximum Voltage above 1000V.
5.	IEEE C37.2	-	Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.

6.	IEEE C37.11	-	Requirements for Electrical Control for AC High-Voltage (>1000V) Circuit Breakers.
7.	IEEE C37.20.2	-	Metal-Clad Switchgear.
8.	IEEE C37.90	-	Relays and Relay Systems Associated with Electric Power Apparatus.
9.	IEEE C37.90.1	-	Surge Withstand Capability (SMC) Tests for Relays and Relay Systems Associated with Electric Power Systems.
10.	IEEE C37.90.2	-	Withstand Capability for Relay Systems to Radiated Electromagnetic Interference from Transceivers.
11.	IEEE C57.13	-	Requirements for Instruments Transformers.
12.	IEEE 1547	-	Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
13.	NEMA	-	National Electrical Manufacturer Association.
14.	NEMA SG 4	-	Alternating Current High-Voltage Circuit Breakers.
15.	NETA ATS	-	NETA, Acceptance Testing Specifications.
16.	NESC	-	National Electrical Safety Code.
17.	Con-Ed, EO-2022	-	Con Edison High-tension Service Specification.
18.	NEC	-	National Electrical Code.
19.	NYCEC	-	New York City Electrical Code.

1.05 DESCRIPTION

A. The Contractor shall provide fully functional Medium-voltage, metal-clad indoor, switchgear assemblies conforming to IEEE C37.20.2 as shown on the Contract Drawings and specified herein and shall consist of the following at a minimum:

1. Draw-out vacuum, electrically operated circuit breakers.
2. Instrument Transformers.
3. Protective Relays.
4. Metering, monitoring and communication equipment
5. DC-Control Voltage System.

B. The Contractor shall provide all necessary communication requirement, wiring, contacts, terminal blocks, protective relays, switches, etc. as required for proper operation, whether shown or not.

C. The Contractor shall coordinate the relay and circuit breaker settings with an independent testing firm, which is required and as described in Section 26 05 73 - Power System Studies.

D. The metal-clad switchgear shall have electronic metering, monitoring and communications as described in this section and Section 26 09 13 - Electrical Monitoring and Communication System.

E. The switchgear shall contain the required interfaces to communicate with PMCSs specified in Division 40 and as shown on the Drawings.

F. The switchgear under this Section is required to serve as service switchgear, the switchgear will be required to comply with NEC and all the Electric Utility requirements inclusive of review of submittals.

1.06 QUALITY ASSURANCE

A. The switchgear manufacturer shall be the manufacturer of all the major components within the switchgear assembly.

B. The manufacturer of the switchgear equipment shall have produced Medium-voltage metal-clad switchgear for minimum period of the last continuous fifteen (15) years.

1. The Contractor shall provide list of at least five (5) installations with similar equipment, to that which will provided under this contract, and demonstrating compliance with these requirements.

2. The Contractor will provide the name, address, telephone number and email of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning and operation of the equipment at the above listed five installations.

C. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Certified copy of the manufacturer's Design Tests made in accordance with IEEE C37.20.2 and conducted on switchgear models and type that is being offered for this contract.
2. Certified dimensioned outline drawings showing equipment layouts, front view and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with Specification requirements, including design and physical arrangement.
4. All information required by the Engineer the for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.
5. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.
6. Erection drawings.
7. Elementary Diagrams and Interconnecting Wiring Diagrams having their terminals identified and indicating the internal wiring and all control and test switch developments.
    a. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable.
    b. Separate drawings for each equipment/compartment shall be supplied.
    c. Wire lists in lieu of wiring diagrams shall not be acceptable.
8. Separate drawings for each compartment shall be supplied including individual compartment point-to-point wiring diagram.
9. Complete three-line diagrams detailing connections for all instrument transformers, relays, meters, etc.
10. Complete Bill of Material.
11. Details of special features.
12. Manufacturer published time-current curves.
13. Instruction manuals of all protective relays for the equipment.
14. Current and potential transformer data, curves, and burden calculations for each CT and PT circuit.
15. Nameplate schedules.
16. Recommended spare parts list with pricing.

17. List of Special Tools.
18. Painting Procedures.
19. List of recommended lubricants.
20. Preliminary Operation and Maintenance manuals.
21. Finalized Operation and Maintenance manuals.
22. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the manufacturer satisfies qualifications stated in this Section.
    b. Seismic qualification certification from the manufacturer including mounting recommendations.
    c. Cybersecurity Equipment Certification
23. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least ninety (90) days in advance prior to conformation of witness testing dates and actual testing.
24. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least ninety (90) days in advance to actual testing, five (5) recent references with phone numbers shall be submitted.
25. Reports.
    a. All shop test and field test reports.
    b. All manufacturer's site visit and acceptance testing reports.
26. The Contractor shall coordinate with and submit the product submittal to Utility for their review and approval before furnishing and installation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Switchgear shall be delivered, stored, protected and handled in accordance with the manufacturer’s instructions, this Section and the Specifications.

B. The Contractor shall inspect and report concealed damage to carrier within the specified time.

C. Switchgear shall be shipped and delivered in convenient shipping splits, each split not to exceed manufacturer recommended length.
    1. Each split shall be mounted on shipping skids and wrapped for protection.
    2. Circuit breakers and breaker accessories shall not be shipped inside their respective compartments.

3. Compartments shall be provided with additional removable stays and braces designed to enable the compartments to withstand any forces of deformation encountered up to and including movements to install the switchgear on its final installation pad.
4. Bus bars with associated hardware for connections between shipping groups/splits shall be shipped inside one of the groups/splits in which it shall be installed.
5. Shipping splits shall contain accessories to permit handling by cranes.
6. Where cranes are not available it shall be possible for splits to be skidded into final positions on rollers and using jacks to raise and lower.

D. Contractor shall store the switchgear and associated equipment in accordance with manufacturer's recommendations.

1. Store all equipment in clean, dry space.
2. Maintain factory protective wrappings or cover with heavy canvas or plastic to keep out dirt, water and construction debris.
3. Within 24 hours of receiving the switchgear the Contractor shall install temporary heaters to prevent condensation during storage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools and supplies with the switchgear and associated equipment, neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

D. Furnish in addition the following spare parts:

1. One (1) set of complete replacement of power fuses for each switchgear assembly.
2. One (1) set of complete replacement indicating lamps for each switchgear assembly.
3. One (1) set of complete replacement color caps lamps for each switchgear assembly.
4. One (1) of each type of protection relay for each switchgear assembly.
5. Two (2) complete sets of fuse replacements of each rating and type installed as part of potential transformer primary and secondary for each switchgear assembly.

6. Two (2) complete sets of fuse replacements of each rating and type installed as part of control power transformer primary and secondary for each switchgear assembly.
7. One (1) spare breaker for each size provided.
8. Two (2) complete sets of control power plug/socket assemblies for each size breaker provided.
9. Four (4) complete sets of power connectors for each size breaker provided.
10. Two (2) per ten pilot lights of each type used.
11. 20 % of installed terminal blocks.

E. Furnish the following protective equipment and tools:

1. The Contractor shall furnish one (1) sets each of protective equipment and tools at each location in which Medium-voltage switchgear will be installed.
2. Protective equipment shall consist of:
   a. Flash Coat shall be 6oz. NoMex minimum with Velcro fasteners
   b. Arc Hood shall be rated 75 cal/cm^2 with UV and Infrared Protection
   c. Rubber Gloves shall be rated minimum 40,000V with leather protection.
   d. Face Shield shall be rated 7.33 cal/cm^2
   e. Safety Helmet
   f. Safety Glasses
   g. Carrying case for the above equipment
3. Protective tools shall consist of:
   a. Grounding Stick
   b. Voltage Tester
   c. Hot Sticks
   d. Grip All Clamp Stick
   e. Grounding Clamps, Ball and Socket ASTM Type 1, Class A, Grade 5
   f. Ground Stud Covers.

F. Furnish the following tools:

1. Two (2) sets of specialized wrenches and tools as required for proper installation, operation and maintenance.

2. One (1) infrared inspection system for thermo-graphic inspection of the power cable terminations or bus connections with the door closed.
3. Two (2) breaker lifting devices or transfer trucks with electric remote racking capability.
4. Two (2) sets of drawout device extension rails. Rails shall be capable of being made integral to the switchgear cubicle and/or breaker transfer truck.
5. Two (2) sets of test plugs and cables for testing the controller while removed from the compartments.
6. One (1) test stand capable of accommodating each size breaker provided.
7. Two (2) lever's for manually racking and charging the breaker.
8. One (1) Ground and Test (G&T) device compliant with the Electric Utility requirements.
9. One (1) Test cabinet for testing electrically operated breakers outside housing.
10. One (1) Levering Crank for moving the breaker between test and connected positions.
11. One (1) Breaker Lifting Yoke used for attachment to breaker for lifting breaker on or off compartment rails.
12. One (1) Ramp for rolling breaker mounted in lower compartment directly onto the floor.
13. One (1) "Dockable" transport dolly for moving breaker about outside its compartment.
14. One (1) Electrical levering device.
15. Furnish test kits to allow protection relay testing without removing system wiring.
    a. Provide test kit for each relay type, if different test kits are required.
    b. Alternatively provide one test kit for any group or number of relays.

G. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance.
    a. Replace all lubricants used during start-up and testing prior to acceptance of equipment.
    b. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

H. The Metal-Clad Switchgear shall be provided with a remote racking device. The remote racking device shall consist of the following:

1. A universal type design, capable of racking single and two (2) high breakers from a distance of 25 feet from the Switchgear door during the racking process.
2. Portable and easy maneuverable and shall include a locking base and cord connected power module suitable for operation from a standard 120 volts receptacle.
3. A remote pendant with insert and remove pushbuttons and light with a 25-foot control cable.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

1. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchgear equipment shall be as manufactured by:

1. Schneider Electric, Andover, MA;
2. ABB, New Berlin, Wisconsin;
3. Or approved equal.

B. Protection Relays shall be as manufactured by:

1. GE
2. Basler
3. SEL
4. Siemens
5. Or approved equal.

C. Ball grounding studs and covers shall be as manufactured by:

1. AB Chance, Centralia, MO;
2. Or approved equal.

D. Ground cable set for use with ball studs shall be as manufactured by:

1. AB Chance, Centralia, MO;
2. Or approved equal.

E. Infrared thermometers shall be as manufactured by:

1. Fluke Phoenix, AR;

2. Or approved equal.

F. Infrared monitoring windows shall be as manufactured by:

1. Fluke Phoenix, AR;
2. Or approved equal.

G. Key Interlock systems shall be as manufactured by:

1. Kirk Key Interlock Company LLC, North Canton, OH;
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Switchgear Ratings

1. 15 kV Switchgear shall have the following ratings and arrangements

a.	Nominal Voltage		13.2 kV
b.	Frequency		60 Hz
c.	Bus arrangement		
	1)	Phase	3 wire
	2)	Neutral	None
	3)	Ground	1
d.	System Grounding		Low resistance
e.	Rated BIL		95 kV
f.	Short Circuit Rating		As Shown on the Contract Drawings
g.	Listings		
	1)	UL as applicable to components.	
	2)	ANSI for switchgear.	

B. General Arrangement

1. The entire switchgear assembly enclosure shall be NEMA 12.
2. All breaker, devices and accessories shall be powered by 125 VDC.
3. Metal-clad switchgear assemblies shall be comprised of vertical sections mechanically and electrically connected to form a complete switchgear assembly.
4. All metal work shall be free from burrs and sharp edges.
5. All connections and servicing shall be facilitated by front and rear access only.
6. The switchgear assembly shall be dead-front on all sides.

7. The switchgear assembly shall be suitable for either bolting or welding to floor sills.
8. The switchgear assembly shall be designed to prevent entry of vermin, dust, dirt, liquids and other agents which are detrimental to its operation.
9. The switchgear assembly shall be suitable for lifting by crane and be capable of being moved by use of jacks and rollers.
10. The switchgear assembly shall be capable of extension from either end without modification to existing structural members.
11. The switchgear assembly shall include the number of vertical sections and be arranged as shown on the Contract Drawings.
12. Structural or formed steel lifting beams for lifting any shipping split of the switchgear shall be supplied by the Contractor.
    a. These beams shall be sufficiently rigid to distribute evenly all strains which may be imposed in handling.
13. The switchgear shall be designed, constructed and installed in conformance with the seismic requirements of the Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.
14. Switchgears shall have MV Surge Protective Devices, Termination Cubicle, and Live Feeder Indicators in accordance with the Con Edison Specification EO-2022.

C. Structure

1. Each vertical section shall be a self-supporting structure consisting of a bolted or welded steel frame with reinforcing gussets.
    a. Front and rear doors, top and side covers shall be assembled on this frame.
    b. All covers and doors shall be 11-gauge steel minimum.
2. Each vertical section shall consist of one or two compartments arranged vertically.
    a. Each compartment shall contain a draw-out breaker or draw-out potential and control power transformer.
    b. One front and one rear door shall be mounted on each vertical compartment, bolted panels are not acceptable.
    c. Each compartment door shall be provided with a full-length hinge, door stop, hex-knob closing screws, hand operated closing latches and provisions for padlocking.

d. Each compartment (front and rear) shall be accessible through padlockable hinged doors. There shall be no exposed low voltage wiring in any medium voltage cubicles.

e. Doors shall have a minimum 105 degree opening and be so designed that there will be no interference with devices when closed or when circuit breakers are inserted for removed.

f. The control, instrumentation, and protection devices associated with the breaker in the compartment shall be mounted on the front compartment door of the same breaker.

g. Terminal blocks, fuse blocks, and some control devices may be mounted inside the compartment on the side panels.

3. When it is not possible to install all the equipment shown on the one line diagram in one breaker compartment, an auxiliary compartment shall be furnished.

a. The auxiliary compartment shall have no provision for accepting a circuit breaker and shall be used to house equipment such as potential transformers, surge arresters, control power transformers, etc., as required.

4. The stationary primary contacts shall be tin-plated and recessed within insulating tubes.

5. A steel shutter shall automatically cover the stationary primary contacts when the breaker is in the disconnected position or out of the compartment. These shutters shall be mechanically interlocked with the positioning of the breaker unit to ensure proper opening and alignment with the racking in and out of the circuit breaker.

6. All penetrations (bus, wiring, etc.) between adjacent switchgear compartment (cubicles) shall be through Utility approved barriers and insulators.

7. Provide rails to allow withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device.

8. Circuit breakers shall be roll-out design.

D. Main Bus and Supports

1. The main bus shall be copper and have non-hydroscopic fluidized bed epoxy flame-retardant and track-resistant insulation.

2. Slip on sleeve type insulation is not permitted.

3. The rated current carrying capacity at the rated ambient temperature shall not be derated for conditions such as skin and proximity effects.

4. The buses for service switchgear shall comply with the New York City Electrical Code (NYCEC).
5. The bus supports between units shall be flame-retardant, track-resistant, glass polyester for 15-kV class.
6. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand the magnetic stresses that would be produced by currents equal to the momentary (close and latch) and interrupting ratings of the circuit breakers.
7. All bus connections shall be rated to carry the rated continuous current, tapered busses are not permitted.
8. The main bus shall have provisions for future extension.
9. All bus joints shall be tin-plated, bolted with at least four (4) bolts per joint and insulated with easily installed boots.
10. The manufacturer shall provide in the form of table or similar arrangement the bolt torque values and instruction for all bus joints, taps and splices in the switchgear assembly, inclusive of values and instruction for outgoing and incoming feeder stabs.
11. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.
12. Expansion joints shall be provided to prevent undesirable or destructive mechanical strains in/at bus supports over the ambient temperature range negative 30 degree C to plus 50-degree C.
13. Access to bus bars shall be through removable bolted panels in the front or back of the switchgear only.
14. Bus phase rotation shall be A-B-C.
15. Bus phasing shall be identified A, B, and C from top to bottom, front to back, and left to right, as viewed from the front of the equipment.
16. Switchgear Bus and Bus Connections shall have an insulated covering which fully insulates the bus to the BIL ratings given in the above table and meets or exceeds the ampere rating of the bus disconnect device.

E. Ground Bus and Bus Grounding

1. A copper ground bus, measuring at least 1/4 X 2 inch in cross section shall extend the entire length of the switchgear and shall be bolted to each vertical section and to each breaker ground contact.
2. The ground bus shall have momentary and short-time ratings equal to that of the main bus.

3. All switchgear equipment requiring grounding shall be connected to the ground bus.

4. The ground bus shall be extended into each outgoing and incoming cable compartment for convenient field connection of cable shields.

5. The station ground-connection points shall at a minimum be located at each vertical end section.

6. The station ground-connection points shall be ground pads or other means shown on the Contract Drawing or acceptable to the Engineer.

7. Equipment ground wires shall not penetrate compartment walls in order to connect to the switchgear ground bus.

F. Ground & Test (G&T) Device

1. The G&T device shall be manufactured to occupy the same cubicle normally occupied by the primary service feeder circuit breaker.

2. The G&T device shall be locked in a Utility approved storage cubicle when not in use.

3. The G&T device shall be rated to meet all voltage and current requirements as the primary service breaker except for the fault interrupting rating.

4. The G&T device shall be equipped with a key interlock system to allow for grounding and testing of the Utility's primary service feeders. The keys that Utility personnel will use to initiate the G&T grounding and testing operations are kept under the Utility's Key Storage Box.

5. Facilities shall be provided to operate (trip and close) the G&T device from a remote position by a twenty-five feet long extension cord with push-button controls.

6. To test the Company's primary service feeder, three, fully rated voltage test receptacles shall be provided on the front of the G&T device which provide individual connections to each phase of the LINE side of the G&T device. Testing of Customer's LOAD side equipment shall also be accomplished via fully rated, voltage test receptacles, which are key interlocked to ensure a safe operation.

7. All test receptacles shall be furnished with shutters to isolate the receptacles while not in use. The shutters shall be key interlocked with the manual operator in such a manner that they cannot be opened unless the G&T device is in the mode of operation assigned and the G&T device is closed (ground is applied). The key interlock shall allow the G&T device to be tripped open only after the test receptacle shutters are closed or after the test probes are inserted and locked into the receptacles. The test receptacles shall be interlocked with the operation of the G&T device to ensure that the probes can only be removed when the G&T device is in the ground position.

8. One set of test probes and with 25 length foot cables shall be furnished with each G&T device. The probes and cables shall be stored at the site. The cables shall have the same insulation voltage rating as the associated switchgear. The test cables shall be furnished with a lug for attachment to a test set.

9. The G&T device shall meet the Utility's interlocking requirements.

G. Wiring and Terminations

1. Compression lugs shall be furnished for all Medium-voltage cable terminations.

2. All Low-voltage wiring in the Medium-voltage parts of the switchgear shall be the shielded type with shield extending to the terminal blocks in Low-voltage compartments.

3. All secondary circuit wiring, including annunciator supervisory circuits and control shall Type SIS rated 600V, 90 degree C and not be smaller than No. 14 AWG.

4. Secondary wiring shall be armored where they pass through primary compartments.

5. PT circuit wiring shall not be smaller than No. 12 AWG and CT circuit wiring shall not be smaller than No. 10 AWG.

6. All wiring shall be neatly arranged and clamped securely to panels to prevent movement and breaking.

   a. Wiring clamps and supports at hinge transition points shall be properly sized to prevent chafing of insulation when the compartment door is opened or closed.

   b. Metal clamps must have insulating inserts between the clamps and wiring.

   c. Connection of cables, supports and cable harnesses to panels with adhesive shall not be acceptable.

7. Connections between shipping splits shall be arranged to require a minimum of field wiring.

   a. Terminal blocks shall be provided on one side of a shipping split break and coiled wires, properly tagged, shall be provided on the other side to facilitate these connections.

8. All secondary leads of each current transformer shall be wired directly to shorting type terminal blocks.

   a. Delta or Wye connections shall be made using jumpers on the load side of terminal block.

9. All wiring in the switchgear shall be labelled at each termination.
10. Terminals shall be identified with labels showing the terminal block and terminal number
11. Terminal blocks shall be barrier type, with a marker strip down the center and shall be suitable for locking spade type terminal lugs.
    a. They shall be located a minimum of 10 in. from the base of the compartment
    b. Each terminal shall be numbered or marked in a clear, easy-to-read manner with labels which refer to the designations used on wiring diagrams.
    c. Parallel rows of terminal blocks shall be spaced a minimum of 6 in. on center.
    d. Twenty percent spare terminals for all instrument and control wiring in each row shall be supplied by the Contractor.
    e. Instrument transformer circuit grounds shall be made independently to the ground bus through a terminal block that is used for Purchaser's connections.
    f. Only one ground connection shall be provided for each circuit.
12. Control wire including space heater AC power bus, P.T. leads, and C.T. leads shall be terminated using locking spade type lugs.
    a. Wire splices and ring type wire lugs will not be accepted.
13. Compartments for spare breakers shall have complete wiring the same as defined for fully equipped spaces.
14. Current and potential transformer secondary windings shall be grounded with a copper conductor not smaller than #10 AWG and connected to a ground bus located as closely as possible to the transformers.

H. Circuit Breaker, Auxiliary, and Termination Compartments

1. Circuit breaker compartments shall house a drawout circuit breaker element and include primary and secondary disconnecting contacts.
2. Each breaker compartment shall be complete with control switch and red, amber, and green indicating lights to indicate breaker position and that it has been tripped.
3. Indicating lights shall be the LED type.
4. Maximum mounting height of breaker control switches shall be 6'-6" above the bottom of the switchgear structure.

5. Grounded safety shutters shall automatically cover stationary contacts when the breaker element is withdrawn from the connected position.
   a. Shutters shall be marked to show Bus or Feeder stationary contact positions and the position of the respective phases.
6. The draw-out type assembly shall be provided with a mechanical interlock to prevent moving the breaker into or out of the operating position unless the breaker is open.
7. The cable compartment shall be at the rear of the breaker compartment.
   a. The design and arrangement of the compartment shall ensure sufficient space for terminating cables with IEEE Class 1 stress cones inclusive of minimum bending radii of the cables to be terminated, current transformers and other related components.
   b. Horizontal barriers shall be provided to isolate circuit terminations when there are two breakers in the same vertical section.
   c. Top or bottom conduit entries shall be provided as indicated on the Contract Drawings.
   d. Connectors for terminations shall be furnished by the Contractor.
8. Where shown on the Contract Drawings the compartment shall be suitable for terminating non-segregated phase bus duct.
9. Current transformers shall be located over the primary insulating· tubes in the separate compartment.
   a. They shall be accessible from the front to permit changing transformers when the unit is deenergized.
10. Zero sequence current transformers shall be provided as shown on the Contract Drawings.
    a. Zero sequence current transformer shall be installed so that its opening is clear for easy installation of field cables.
    b. Field drilling of holes in supports is not acceptable.
11. Auxiliary compartment shall be used to mount potential transformers with fuses, surge arresters, control power transformers, etc.
    a. Where rollout trays are provided to mount potential or control power transformers, the movable carriage shall be equipped with primary and secondary disconnecting devices, grounding devices and a safety barrier.
    b. Auxiliary compartments shall be furnished when all auxiliary equipment cannot be accommodated in the breaker unit.

12. Circuit breaker and auxiliary compartments shall be equipped with space heaters.
    a. Each space heater circuit shall be rated for 240VAC and operated via fused circuits from the 120 VAC power bus and shall be wired through a breaker truck auxiliary switch.
    b. Heater circuits shall be energized when the breaker is open or is removed from operating position.
    c. Heaters shall be wired from temporary connections when the switchgear is in storage.
13. The termination compartment shall be sized to meet code and Utility requirements, and to ensure ease of access for maintenance of the primary service feeder potheads, phase and ground buses, and the Live Feeder Indicators as noted below.
14. Each primary service feeder termination compartment shall furnish and install with two neon glow tubes per phase. The neon glow tubes shall be installed on the line side of any primary service feeder disconnecting device. Viewing windows of shatter proof material shall be provided in the compartment door(s) to permit observation of the neon glow tubes by an operator.

I. Circuit Breakers

1. All circuit breakers shall be vacuum interrupter, horizontal draw-out type, provided with self-aligning, bus-side and load-side disconnecting devices (disconnecting fingers) and the following ratings:

a.	Rated Ambient Temperature	40 degrees C
b.	Frequency	60 Hz
c.	No of poles	3
d.	Rated Maximum Voltage	15 kV
e.	Rated BIL	95 kV
f.	Rated Current	1200 A
g.	Rated Short-Circuit Current at maximum rated kV.	63 kA
h.	Closing and Latching Capability	130 kA
i.	Short Time Rating	63 kA
j.	Rated Interrupting Time	3 cycles

2. All breakers of the same rating shall be electrically and mechanically interchangeable and fit any breaker compartment of the same rating.

a. Compartments shall be interlocked or draw-out mechanisms designed with coded plates to prevent insertion of incorrectly rated breakers.

b. Grounded-steel protective front covers on the breaker truck shall be provided to prevent access to the operating mechanism or live parts both DC and AC when the compartment door is opened.

3. All breakers shall be electrically operated by a motor-charged, heavy-duty spring-type stored-energy mechanism.

a. After the circuit breaker is closed, the motor shall charge the closing springs for subsequent operation of the breaker.

b. The stored-energy mechanism shall be automatically discharged prior to the circuit breaker being withdrawn from or inserted into its compartment.

c. The electric motor shall be a universal motor rated at 125 VDC and shall operate from 90 to 140 VDC.

d. The stored energy closing springs shall be suitable for manual as well as electrical charging.

e. Breakers shall be mechanically and electrically trip-free in all positions.

f. Circuit breakers shall be equipped with an anti-pumping feature.

4. Each circuit breaker shall be furnished with mechanical indicators for:

a. Positive indication of breaker open or closed position

b. Breaker closing spring charged or discharged position

c. Positive indication of breaker position, i.e. connected test, or disconnect

d. To prevent the circuit breaker from being racked in or out unless the breaker is open.

e. To prevent closing the breaker by any means while it is being racked in or out.

5. Each circuit breaker shall be furnished with a sufficient number of auxiliary switch contacts (52 AUX), mechanism operated switch contacts, (52 MOC) and truck-operated switch contacts (52 TOC) to provide all necessary interlocks for proper operation of connected equipment including remote and local positions.

a. All auxiliary switch contacts shall be field reversible.

b. All auxiliary, mechanism, truck-operated and spare contacts shall be completely wired to terminal blocks whether in immediate use or not.

c. All breakers of the same rating shall have the same number of auxiliary, mechanism, truck-operated and spare contacts.

d. The following minimum contacts on each switch shall be provided:

1) 52 AUX, 3 NO and 3 NC

2) 52 MOC, 3 NO and 3 NC

3) 52 TOC, 3 NO and 3 NC

6. Trip and close levers for manual operation shall be furnished on the circuit breaker element.

7. When the circuit breaker is in the test position, control circuits shall permit local operation of the breaker.

a. Circuits for remote operation of the breaker shall be disconnected when the breaker is in the test or disconnect position.

b. The breaker shall have provision for padlocking in the test and disconnect positions.

c. When padlocked in the disconnect position the breaker element shall be locked in the compartment.

8. Circuits used for energizing space heaters and for interlocking with other electrically operated circuit breakers and wired through "b" auxiliary contacts shall be maintained automatically in the disconnect position of the circuit breaker.

9. Grounding of the circuit breaker base shall be automatically applied before primary contacts are made and shall be maintained until the primary contacts have been separated by a safe distance.

10. A suitable mechanism for manually inserting and withdrawing the removable element shall be provided for each circuit breaker.

a. The mechanical advantage ratio of the mechanism shall be such that the device may be operated easily by one person.

11. The SES circuit breaker shall be electrically interlocked with the transformer secondary (MV Switchgear main) circuit breaker so that the SES circuit breaker cannot be closed unless the transformer secondary circuit breaker is opened. The SES circuit breaker shall trip whenever the transformer secondary circuit breaker is closed.

J. Protective Relays

1. Features Applicable to all Protective Relays.

a. The Contractor shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the Contract Drawings and specified in this Section.

b. Protective Relays shall be solid-state, microprocessor-based, multi-functional type that operates from the 5-ampere secondary output of current transformers and the 120 VAC secondary output of potential transformers.

c. Alternating-current devices, instruments and relays shall be suitable for operation from 5 amp current and 120V potential circuits at 60Hz.

   1) They shall not be injuriously affected by primary short circuit current rating of the assembly.

   2) All devices, instruments and relays shall be accurately adjusted and calibrated before shipment.

   3) The arrangement of equipment on the front of the switchgear panel shall be subject to approval by the Engineer.

d. Protective relays shall be equipped with semi flush mounted cases, totally withdrawable, with integral test facilities and automatic current transformer shorting with sequenced disconnect, and conform to ANSI C37.90.

e. Static relays shall be qualified for surge withstand capability (SWC) in conformance with ANSI C37.90.

f. Control relays shall be designed to relieve control and auxiliary switches of interrupting currents above their rating.

   1) The control arrangement equipment shall be such that a maintaining contact may be used if desired.

   2) Two spare control relays with 125VDC coil and four normally open and four normally closed contacts shall be provided and completely wired to terminal blocks.

g. Alarm relays shall be installed to monitor 125 VDC power supply to circuit breaker control circuit, to provide input to remote alarm should the power supply fail.

h. Instrument and relay phasing shall be left to right or top to bottom with neutral relays underneath phase grouping.

i. Where possible, relays shall be mounted above the control switch on their respective panels.

j. Relays shall be located as close as possible to the respective switches and shall be placed at a height convenient for adjustment by a worker standing on the floor.

k. The manufacturer shall furnish and install all contacts, relays, switches, etc. required for proper operation, per the Contract Drawings, Specifications and as required.

l. "Lead seals" shall be installed on all relays after they has been installed, commissioned into service and accepted.

m. All relays shall be set based on studies as described in Section 26 05 73 – Power System Studies.

n. The Contractor shall test and calibrate each protective relay in accordance with the manufacturer's recommendation, power system studies and best industry practice.

o. All protective relays shall be utility grade in drawout cases.

p. Auxiliary relays in protective relay circuits shall be utility grade with screw terminal connections (plug-in relays are not acceptable).

q. All protective relays shall provide target indication when the associated device is tripped.

r. Trip circuit monitoring is required for all circuit breakers and the associated lockout relays.

s. Trip circuit monitoring shall be equipped with an alarm contact that is connected to the substation monitoring system.

t. The Contractor shall provide active standby (second) protective relay with the same protective functions. The active standby protective relay shall be wired such that the loss of one relay shall not interrupt the protective functions of the second protective relay. Loss of one protective relay shall initiate an alarm at the annunciator panel and remote location.

2. Microprocessor Protective Relays

a. Microprocessor Protective Relays shall be multifunction type incorporating multiple IEEE C37.2 device functions in a single device.

b. The device functions shall be as shown on the Contract Drawings or as determined by Section 26 05 73 – Power Systems Studies.

c. The relays shall have built-in self-test functions with an alarm contact that shall be connected to the substation monitoring system.

d. The relays shall provide protective functions for each of the three (3) phases, neutral and ground as shown on the Contract Drawings.

e. The relays shall be true RMS sensing of each phase and ground.

1) Ground element shall be capable of being utilized in residual, zero sequence, or ground source connection schemes, or deactivated.

f. The primary current transformer rating being used for phase and ground protection feeding the device shall be programmable for current transformers with primary current ratings from 5 through 5,000 amperes.

g. Both the phase and ground protection curves shall be independently field selectable and programmable with or without load.

h. Curves shall be selectable from the following:

1)	IEEE:	Moderately inverse, very inverse, extremely inverse
2)	IEC:	A, B, C or D.
3)	Thermal:	Flat, It, I^2t, I^4t

i. Thermal curves shall be similar to those on Low-voltage trip units for close coordination with downstream devices.

j. Selectable short time delay pick-up and short time delay time settings shall also be provided.

k. Phase instantaneous over-current trip shall have field programmable pick-up points from 1.0 to 25 times current transformer primary rating or NONE.

1) In addition, a field selectable (ON or OFF) discriminator circuit shall be included such that when phase instantaneous over-current has been programmed to NONE, the discriminator circuit shall protect against currents exceeding 11 times current transformer primary rating, only when the breaker is closed.

l. The relays shall be field configurable to have either of the following function combinations assigned to type "a" contacts:

1) one contact assigned ANSI 51 phase and ANSI 51 ground and the other contact assigned ANSI 50 phase and ANSI 50 ground;

2) one contact assigned ANSI 51/50 phase and the other contact assigned 51/50 ground.

m. The relays shall have a built-in alphanumeric display capable of displaying the following information with metering accuracy of plus/minus one (1) percent of full scale (I_n) from 0.04 X I_n to 1 X I_n

and plus/minus two (2) percent of full scale (I_n) from 1 X I_n to 2 X I_n:

1) Individual phase currents and voltages.

2) Ground current and voltages.

3) Cause of trip.

4) Magnitude and phase of current or voltage causing trip.

5) Peak current and voltage demand for each phase and ground since last reset.

6) Current and potential transformer primary rating.

7) Programmed phase and ground set-points.

n. The relays shall have the following features:

1) Integral manual testing capability for both phase and ground.

2) Zone selective interlocking capability for short time and ground fault protection.

a) This function shall be provided and factory wired.

b) Where zone selective interlocking is not an integral part of the protective device, a full bus differential scheme shall be required for both phase and ground in addition to specified time over-current and instantaneous over-current phase and ground fault protection.

c) Bus differential scheme shall be provided with separate differential current transformers for all incoming and out-going loads, as well· as appropriate differential relays (ANSI 87 and 87G) as approved by the Engineer.

3) Continuous self-testing of internal circuitry.

4) Unit failure alarm contact for customer use.

5) Programmable lockout/self-reset after trip function.

6) Programmable set-points for device curve selection.

7) Programmable inputs, such as current transformer ratios.

8) Access to program and test modes shall be via sealable hinged cover for security.

9) The relays shall be suitable for operating temperatures from -30 degrees to 55 degrees C. Relay and relative humidity from 0 to 95% non-condensing.

10) The relays shall have the communication capability via local area network compatible to the electrical monitoring system.

11) Relays shall be capable of the following over the communication network:

a) Ability to transmit all information contained in the relay such as currents, set-points, cause of trip, magnitude of trip current, and open- close trip status.

b) Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is dip switch configured in remote close/open mode.

12) Relays alarm and/or trip contacts shall not change state if power is lost or an under-voltage occurs.

a) These contacts shall only cause a trip upon detection of an over-current or fault condition based upon programmed settings.

13) The relays shall be suitable for operating on control power with a nominal input voltage of 125 volts DC.

o. The relays shall provide for complete real time monitoring and metering functions. These shall include:

1) A fault locator with a record of the last 10 faults.

2) An event recorder with a record of the last 128 events.

3) Waveform capture with storage of 128 cycles of data.

4) A power simulation feature shall be included to allow testing without the need for external voltage and current inputs. User interfaces shall include:

5) A 40-character display and a keypad.

6) Indicator LEDs on the front panel which shall provide a quick visual indication of status.

7) A front panel RS232 serial port, which shall provide easy computer access.

8) Two (2) rear RS485 ports, one of which can be configured as a RS422 port.

p. The relays shall include the following user interfaces:

1) A LED display, control keys and full numeric keypad located on the front panel.

2) LED indicators located on the front panel which shall indicate the status of the protection relay, generator, and output relays.

3) An RS232 port located on the front panel with a baud rate of 9600 bps.

4) Two (2) RS485 ports located on the rear of the unit with baud rates from 300 to 19,200 bps.

5) The communications ports shall allow simultaneous independent access using Modbus® RTU and DNP 3.0 protocol.

6) Windows® based PC software which enables setpoint programming, file storage, on-line help, and real time display of status and measured data.

q. Relays shall trip the associated circuit breaker via a manually reset lockout relay.

3. Feeder Management Relays

a. Feeder management shall be provided using multifunction-microprocessor relays complete with protection, metering, and monitoring functions.

b. The feeder management relays shall provide primary protection and management of distribution feeders. Protection shall include:

1) Time overcurrent.

2) Instantaneous overcurrent.

3) Directional overcurrent.

4) Undervoltage and overvoltage.

5) Negative sequence voltage.

6) Undervoltage automatic restoration.

7) Bus under frequency.

8) Under frequency automatic restoration.

9) Control shall include

a) manual close controls

b) cold load pick-up control

c) four (4) settings groups

d) 20 programmable logic inputs

e) two (2) breaker control relay outputs

f) one (1) internal failure relay output

g) five (5) programmable relay outputs

h) one (1) solid state trip output, and

i) eight (8) analog transducer outputs.

4. Transformer Management Relays

a. Protection for power transformers shall be provided by a highspeed multi-processor multi-function based relay.

1) The following protection functions shall be included:

2) Three phase differential current relays with dual slope percentage differential restraint and harmonic restraint.

3) Unrestrained differential overcurrent.

4) Two (2) instantaneous overcurrent elements for each phase winding, calculated neutral, and ground current.

5) One (1) time overcurrent element for each phase winding, calculated neutral, and ground current.

6) Negative sequence overcurrent.

7) Under frequency and rate-of-change elements for load shedding.

8) Over frequency element.

9) Overexcitation to protect against overvoltage and over fluxing.

b. Enhanced flexibility of the protection system shall be provided by the following:

1) Auto-configuration of transformer CTs to wye configuration.

2) Programmable protection logic to allow any combination of protection elements, logic inputs, and timers to be assigned to any output.

3) Adaptive harmonic restraint to prevent false tripping during inrush periods.

4) Multiple set point groups.

5) Dynamic CT ratio mismatch correction.

6) Adaptive time overcurrent curves which take into account the transformer capability when supplying non sinusoidal load currents.

c. The following inputs and outputs shall be provided:

1) 16 logical inputs.

2) One (1) analog input (optional).

3) One (1) high speed electronic output.

4) Eight (8) electro-mechanical relay outputs.

5) Seven (7) analog output channels (optional).

6) An IRIG-B input.

d. Logic shall be provided to define configurable outputs.

5. Individual Protective Relays.

a. Relays for specific protective functions where shown on the Contract Drawings, which are not incorporated in the Feeder or Transformer relays described in this Section shall have the following features:

1) Microprocessor based control functions.

2) Front mounted potentiometers, settings for pick-up and drop-out values, timing values, etc.

3) 125 VDC control voltage.

4) Output contacts.

5) Target indicators.

6) Push-to-energize output switches for testing purposes.

7) Surge withstand capability per ANSI/IEEE C39.90.1-1989, Surge Withstand Capability Test.

6. Zero sequence voltage detection for ungrounded systems (device numbers 27 & 59) that trip the associated circuit breaker directly. These relays shall be supplied from a phase-to-ground connected VT located on the load side of the primary service feeder circuit breaker.

7. Lockout Relays

a. Lockout relays (Device 86) shall be heavy-duty, multi-contact type with pistol grip handle control switch.

b. The mechanical target on the escutcheon plate assembly shall indicate relay position.

c. Reset position shall be indicated by a black target and tripped indication shall be by an orange target.

d. Coil voltage shall be 125 VDC.

K. Instrument Transformers

1. Current and potential transformers shall be furnished for the switchgear relays, breakers, meters and transducers, and for converting bus voltage to appropriate control voltages.

2. Current and Potential transformers shall comply with IEEE C57.13

3. There shall be two (2) separate sets of transformers for each circuit breaker circuit.

a. One set shall be used exclusively for relaying circuits and the other set shall be used exclusively for metering circuits.

4. The current and potential transformers shall have accuracy Classes confirming to IEEE C57.13 unless the Electric Utility has detailed specific requirements.

5. Ring type current transformers shall be furnished as indicated on the Contract Drawings.

6. The thermal and mechanical ratings of the current transformers shall be coordinated with the momentary current rating of the circuit breakers.

7. The standard location for the current transformers on the bus side and load side of circuit breaker units shall be front accessible to permit adding or changing current transformers without removing Medium-voltage insulation connections.

8. Shorting terminal blocks shall be furnished on the secondary of all the current transformers circuits.

9. Potential and control power transformers of the quantity and ratings shall be supplied as indicated on the Contract Drawings and as required.

10. Potential transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment.

11. Control power transformers up to 15 kV, 15 kVA, single-phase shall be mounted in drawout drawers.

12. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement.

a. Shutters shall isolate primary bus stabs when drawers are withdrawn.

13. A mechanical interlock shall be provided to require secondary breakers to be open before potential and control power primary fuse drawer can be withdrawn.

14. The Potential transformers secondaries shall be non-fused for protective relay connection.

15. The Potential transformers and current transformers shall be selected with an insulation rating to withstand the same dielectric proof test described in the section and Utility requirement.

16. All instrument voltage transformers shall have a nominal voltage accuracy class as listed below:

a.	Nominal Voltage	13.2 kV
b.	Rated Voltage	15 kV
c.	Class	0.6 z
d.	BIL Rating	95 kV

17. Current transformers shall not saturate for the maximum available fault current that passes through the CT and the actual CT secondary burden.

18. All current transformers shall be selected to meet or exceed the following short-time RMS current values:

a.	Nominal Voltage	13.2 kV
b.	Rated Voltage	15 kV
c.	Rated Current Mechanical	71.0A
d.	Rated Current Thermal	45.0A

L. Metering, Monitoring and Communications

1. Provide customer metering, monitoring and communication devices where shown on the Contract Drawings.

2. Customer metering monitoring and communication installed in Medium-voltage metal-clad switchgear shall comply with the requirements of Section 26 09 13 – Electrical Monitoring and Communication System.

3. Provide a separate customer metering compartment with front hinged doors.

4. Customer metering compartments shall as applicable:

   a. Comply with the General Arrangement requirements detailed under this Section.

   b. Comply with the Structure requirements detailed under this Section.

   c. Comply the Main Bus and Supports requirements detailed under this Section.

d. Comply with the Ground Bus and Bus Grounding requirements detailed under this Section.

e. Comply with the Wiring and Termination requirements detailed under this Section.

f. Comply with the Circuit Breaker and Auxiliary Compartments requirements detailed under this Section.

5. Customer metering, monitoring and communication shall be supplied by separate metering current transformers as shown on the Contract Drawings

6. Customer metering, monitoring and communication shall be supplied by separate metering potential transformers as shown on the Contract Drawings.

7. Furnish, install and maintain mounting facilities and wiring for Utility meters, revenue metering instrument transformers, meter devices and phasing receptacles in accordance with Utility Specification MES-350 and its support documents.

8. Revenue metering instrument transformers shall be mounted at a minimum distance of 6 inches and a maximum of 84 inches from the cubicle floor. All revenue metering transformers are supplied by the Utility. 15 kV class revenue metering voltage transformers are primary fused.

9. Two phasing receptacles, from different feeders, shall be installed on the front of each Utility Metering cubicle. Furnish, install and connect all required conduit and wire for connection of the phasing receptacles.

M. Fully-Equipped and Spare Compartments

1. Compartments designated as spaces indicated for future breakers on the Contract Drawings shall be provided with complete wiring, terminal blocks, and mounting provisions for future breakers, including current transformers, metering, all outgoing wiring for future remote breaker control, alarm, and indication.

2. Two (2) 12-point terminal blocks shall be provided as spares.

3. Drilling provisions for switches, meters, etc. on compartment doors are not required.

4. Compartments designated as spaces for spare breakers shown without current transformers and metering shall have complete wiring the same as defined for fully-equipped spaces.

5. Compartments designated as spaces shall not contain any equipment.

N. Circuit Breaker Test Cabinet

1. One Test Cabinet shall be furnished for inspection and test of the removable vacuum circuit breaker elements.

2. The Test Cabinet shall be furnished with a control switch and indicating lights to permit operating the breaker electrically from the cabinet and shall also include a plug and cable for connection to the breaker.

3. The Test Cabinet shall be mounted within the facility housing the switchgear or as shown on the Contract Drawings and be completely wired.

O. Key Interlock Systems

1. Key interlock systems shall be provided as indicated on the Contract Drawings and as specified herein.

2. Key interlock systems shall be designed and arranged as shown on the Contract Drawings to enable or prevent the paralleling of multiple utility sources or multiple feeders which are normally connected to the switchgear busses.

3. The Contractor shall comply with Electric Utility requirements for key interlock system installed on the switchgear lineups.

4. There shall be clear access to all key interlocks.

5. Wires shall be routed such that they do not hinder the clear access to the key interlocks.

P. DC Control-Voltage System

1. The Contractor shall furnish and install a Central Battery System to power the 125 VDC Control-Voltage System (capacitor trip devices are not acceptable) from which all breakers, control, protective and accessories devices shall operate.

2. The layout of the DC Control-Voltage System shall be as shown on the Contract Drawings

3. The Central Battery System shall be as detailed in Section 26 33 23 – Central Battery System.

4. The Central Battery System and the DC Control-Voltage System shall comply with the Electric Utility requirements

Q. Arc Flash Mitigation

1. The Switchgear shall be equipped with energy-reducing arc flash mitigation system. The Switchgear shall have Arcflash Reduction Maintenance System with integral selector switch with (5) five arc-flash reduction settings.

2. The Contractor shall provide Switchgear arc energy reduction system documentation to the Engineer.

R. MV Switchgear Mimic (Remote Control) Panel

1. The Contractor shall furnish and install a stand-alone MV Switchgear Mimic (remote-control) Panel as shown the Contract Drawings. This mimic panel shall be part of the MV Switchgear Mimic Panel.
2. It shall be possible to execute from the Mimic Panel all the operations an operator can accomplish while standing directly in front of the switchgear such as opening and closing breakers and verification by status indicators.
3. Mimic Panel shall have the switchgear single line diagram shown graphically.
    a. The graphic display shall include the bus and each breaker.
    b. Nameplates shall identify each breaker number, the load it feeds, etc.
4. Each switchgear breaker controlled at the Local Mimic Panel shall include a breaker control switch, green, red and amber indicating lights to display that the breaker is open, closed or tripped, respectively.
5. The Contractor shall submit all details of the mimic panels including the display, equipment layout, wiring, and materials, for Engineer approval.
6. Arc Flash Study submittals shall demonstrate that operations at the Local Mimic Panels do not represent a direct exposure to arc blasts energies from the front or rear of the switchgear lineup for any of the controlled breaker.
7. All indicator lamps shall be low burden LED type with power taken from the same source as the switchgear.
8. All breaker control switches shall be of the same make and model as used on the switchgear.
9. The Mimic Panel shall be fabricated in UL listed panel shop.
10. The panel shall be NEMA Type 12.
11. The panel shall be an enclosed, front accessible and fabricated from reinforced sheet steel.

S. Insulating Floor Mat

1. The Contractor shall furnish and install non-conductive floor mat in front of the switchgear to provide insulation for the workers.
2. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. Painting shall be in accordance with Section 09 91 90 – Painting.

2. All internal and external metal surfaces of the switchgear/s shall be thoroughly cleaned, rinsed and phosphatized prior to painting.

3. The switchgear shall be painted with an thermosetting electrostatically applied polyester powder with final baked on average thickness between 1.5 to 2.0 mils.

4. The color of all interior finishing coats shall be white.

5. The color of the exterior finishing coats shall be ANSI No. 61 gray.

6. The finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass ASTM B117 5% salt spray test for a minimum of 1000 hours.

7. A supply of touch-up paint shall be provided from paint used for the final coat.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Each switchgear lineup shall be completely assembled, wired and tested at the factory, including all buses, connections, insulator, terminals and terminal blocks, to demonstrate that it has been properly assembled, properly lubricated, is not overheating, is not overloading and has no electrical or mechanical defects.

2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment.

3. Shop test shall be in accordance with the latest revisions of IEEE C37.20.2, IEEE C37.09 and shall demonstrate that the equipment tested conforms to the requirements specified.

4. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

5. Switchgear shop tests shall include the following:

a. The Contractor shall perform all tests required by Utility based on their latest specification (EO-2022 and EO-4019).

b. Breaker Testing

1) All tests shall be in accordance with the latest version of IEEE C37.09.

2) Alignment test with master cell to verify all interfaces and interchangeableness.

3) Circuit breakers operated over the range of minimum to maximum control voltage.

4) Factory setting of contact gap.

5) One-minute dielectric test per IEEE standards on primary and secondary circuits with breakers open and closed.

6) Alignment test with master breaker to verify interfaces.

7) Operation of wiring, relays and other devices verified by an operational sequence test.

8) Five (5) mechanical operations tests of each breaker.

9) Timing testing of all breakers.

c. Switchgear Line up Tests

1) Physical inspection shall be performed including torque tests of bus bolts.

2) Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.

3) Continuity test shall be performed on power and control wires.

4) Functional operations test which shall include pick up, dropout, time delay, sequence and polarity.

5) Primary hi-potential tests shall be performed.

a) Primary current carrying parts shall be tested between phases, phase to ground, and line to load.

b) The applied voltage shall be twice rated voltage plus 1000 for 1 minute.

6) Hi-Potential tests on control and secondary wiring shall be performed.

a) Control circuit wiring shall be tested for 1500 volts to ground for 1 minute.

7) Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation. Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests.

3. For the Witnessed Shop Test the Contractor shall perform all of the Certified Tests in the presence of the witnesses.

4. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

5. Switchgear shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Switchgear equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. Switchgear equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Switchgear equipment shall be installed in accordance with Utility specification and standard.

D. Switchgear equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

E. Steel channels shall be provided for support of switchgear equipment.

F. Switchgear equipment shall be securely mounted to mounting surface with anchor bolts.

G. Anchor switchgear to satisfy the specified seismic requirements in accordance with the anchorage details.

H. Install nameplates for identification of switchgear equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, switchgear shall be field tested for operation and conformance.

2. The Contractor shall perform field tests in accordance with this Section and Specifications.

3. The field tests shall be witnessed by the Engineer, Utility Engineer, and certified by the Contractor.

4. Switchgear testing shall be performed by the manufacturer's representative, prior to energizing equipment.

5. Equipment shall not be energized without the permission of the Engineer and Utility.

6. Prior to energization, the Contractor shall perform all test require by Utility and shall consist at a minimum of the following:

   a. The Contractor shall perform a service equipment Acceptance Test and submit the results to the Utility and Engineer for review and approval.

   b. The Contractor shall require to perform the certified relay testing and submit their results to the Utility and Engineer for review and approval.

   c. All required testing shall be performed by firms certified by InterNational Electrical Testing Association (NETA) to perform the testing.

   d. The Contractor shall allow the Utility to perform all required tests on the combined (Utility/Customer) primary service feeder cables and switchgear terminations in conformance with the latest revision of Company Specification EO-4019.

7. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:

   a. Breakers and vertical sections shall be checked to determine that they have been properly installed, lubricated and connected.

   b. Control equipment and connections shall be checked to determine that they are not defective.

   c. Device settings and adjustments shall be verified.

   d. Mechanical and electrical interlocks shall be inspected and controls shall be checked for proper operation.

   e. Functional tests verifying the operations of all controls and displays.

   f. Infrared testing shall be performed once after initial energization of the switchgear and a second time after full load has been applied continuously for (24) hours.

B. Manufacturer’s Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the switchgear, check the switchgear installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the Contractor and the City’s operations

and maintenance staff in the care, operation and maintenance of the switchgear.

2. The Contractor shall provide switchgear equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

3. Minimum number of manufacturer's representative site visits per switchgear:

4.

Construction Phase	Minimum Number of Visits	Minimum Person(s) per Visits	Minimum Number of Day(s) per Visit
Installation	1	2	5
Field Tests	1	2	3
Acceptance Testing	1	2	3
Training	1	2	2

5. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

6. The Engineer shall have the right to reallocate any unused person-days.

7. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.

   a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

8. The service representative shall sign in and out with the Engineer on each day they are at the site.

   a. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide switchgear Start-Up services and Training in accordance with this Section and the Specifications.

1. Acceptance Testing

   a. The Contractor shall provide acceptance testing of the switchgear.

   b. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.

c. The acceptance testing shall be witnessed by the Engineer, Utility Engineer and certified by the Contractor.

d. Acceptance testing inspection shall be performed on each switchgear. At a minimum, Inspection shall include the following:

1) Physical, electrical and mechanical condition shall be inspected.

2) Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

3) Ventilating air passageways shall be inspected for blockage.

4) All connections shall be inspected for high resistance.

5) Electrical and mechanical interlock systems shall be checked for proper operation.

6) Insulators shall be inspected for evidence of damage or contamination.

7) Equipment shall be cleaned and lubricated as required.

2. Acceptance electrical testing shall be performed on each switchgear. Testing shall include at a minimum of the following:

a. Ground-resistance tests shall be performed.

b. Insulation-resistance tests shall be performed on each bus section, on each switch, transformer and circuit breaker, phase-to-phase and phase-to-ground.

c. An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

d. Contact-resistance test shall be performed.

e. Control and metering wiring performance test shall be performed.

f. Circuit breaker trip characteristics shall be determined by primary current injection.

g. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.

h. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place into satisfactory operation Medium-voltage, metal-clad switchgear complete with all auxiliary equipment as shown on the Contract Drawings and specified in this Section.

B. The switchgear shall be suitable for application to 15 kV, 3-phase, 3-wire, 60 Hz systems.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 26 05 11 – General Electrical Requirements.

C. Section 26 05 27 - Grounding

D. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems

E. Section 26 05 53 – Identification for Electrical Systems

F. Section 26 05 73 – Power System Studies.

G. Section 26 05 75 – Shock Hazard and Arc Flash.

H. Section 26 08 11 – General Electrical Testing.

I. Section 26 33 23 – Central Battery System.

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 VAC and within the 600 VAC Class.

4. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 VAC and below 99,000 VAC.

B. Reference Standards

1.	IEEE C37.010	-	Application Guide for AC High-Voltage Circuit Breakers (>1000VAC) Rated on a Symmetrical Current Basis.
2.	IEEE C37.04	-	Rating Structure for AC High-Voltage Circuit Breakers.
3.	IEEE C37.06	-	AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000V.

4.	IEEE C37.09	-	Test Procedure for AC High-Voltage Circuit Breakers with Rated Maximum Voltage above 1000V.
5.	IEEE C37.2	-	Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.
6.	IEEE C37.11	-	Requirements for Electrical Control for AC High-Voltage (>1000V) Circuit Breakers.
7.	IEEE C37.20.2	-	Metal-Clad Switchgear.
8.	IEEE C37.90	-	Relays and Relay Systems Associated with Electric Power Apparatus.
9.	IEEE C37.90.1	-	Surge Withstand Capability (SMC) Tests for Relays and Relay Systems Associated with Electric Power Systems.
10.	IEEE C37.90.2	-	Withstand Capability for Relay Systems to Radiated Electromagnetic Interference from Transceivers.
11.	IEEE C57.13	-	Requirements for Instruments Transformers.
12.	IEEE 1547	-	Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
13.	NEMA SG 4	-	Alternating Current High-Voltage Circuit Breakers.
14.	NEC	-	National Electrical Code.
15.	NYCEC	-	New York City Electrical Code.
16.	Con-Ed, EO-2022	-	Con Edison High-Tension Service Specification.
17.	ASTM D178	-	Electrical Switchboard Matting.

1.05 DESCRIPTION

A. The Contractor shall provide fully functional Medium-voltage, metal-clad, indoor, switchgear assemblies conforming to IEEE C37.20.2 as shown on the Contract Drawings and specified herein and shall consist of the following at a minimum:

1. Draw-out vacuum, electrically operated circuit breakers.
2. Instrument Transformers.
3. Protective Relays.

4. Metering, monitoring and communication equipment.
5. DC-Control Voltage System.

B. The Contractor shall provide all necessary communication requirement, wiring, contacts, terminal blocks, protective relays, switches, etc. as required for proper operation, whether shown or not.

C. The Contractor shall coordinate the relay and circuit breaker settings with an independent testing firm, which is required and as described in Section 26 05 73 - Power System Studies.

D. The metal-clad switchgear shall have electronic metering, monitoring and communications as described in this Section. The communications shall be able to transmit the power usage of individual breaker to local area network.

E. The switchgear shall contain the required interfaces to communicate with PMCSs specified in this Section and as shown on the Drawings.

F. The switchgear under this Section is required to comply with NEC and all the Electric Utility and New York State Building Codes requirements inclusive of review of submittals.

1.06 QUALITY ASSURANCE

A. The switchgear manufacturer shall be the manufacturer of all the major components within the switchgear assembly.

B. The manufacturer of the switchgear equipment shall have produced Medium-voltage metal-clad switchgear for minimum period of the last continuous fifteen (15) years.

1. The Contractor shall provide list of at least five (5) installations with similar equipment, to that which will provided under this contract, and demonstrating compliance with these requirements.
2. The Contractor will provide the name, address, telephone number and email of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning, and operation of the equipment at the above listed five installations.

C. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required

approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Certified copy of the manufacturer's Design Tests made in accordance with IEEE C37.20.2 and conducted on switchgear models and type that is being offered for this contract.

2. Certified dimensioned outline drawings showing equipment layouts, front and side views and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.

3. Cross sections and details, as required, to satisfy the Engineer, that all components conform to Specification requirements, including design and physical arrangement.

4. All information required by the Engineer the for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.

5. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.

6. Erection drawings.

7. Elementary Diagrams and Interconnecting Wiring Diagrams having their terminals identified and indicating the internal wiring and all control and test switch developments.

   a. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable.

   b. Separate drawings for each equipment/compartment shall be supplied.

   c. Wire lists in lieu of wiring diagrams shall not be acceptable.

8. Separate drawings for each compartment shall be supplied including individual compartment point-to-point wiring diagram.

9. Complete three-line diagrams detailing connections for all instrument transformers, relays, meters, etc.

10. Complete Bill of Material.
11. Details of special features.
12. Manufacturer published time-current curves.
13. Instruction manuals of all protective relays for the equipment.
14. Current and potential transformer data, curves, and burden calculations for each CT and PT circuit.
15. Nameplate schedules.
16. Recommended spare parts list with pricing.
17. List of Special Tools.
18. Painting Procedures.
19. List of recommended lubricants.
20. Preliminary Operation and Maintenance manuals.
21. Finalized Operation and Maintenance manuals.
22. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the manufacturer satisfies qualifications stated in this Section.
23. Reports.
    a. All shop test and field test reports.
    b. All manufacturer's site visit reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Switchgear shall be delivered, stored, protected and handled in accordance with the manufacturer’s instructions, this Section and the Specifications.

B. The Contractor shall inspect and report concealed damage to carrier within the specified time.

C. Switchgear shall be shipped and delivered in convenient shipping splits, each split not to exceed fifteen 10 feet in length.

1. Each split shall be mounted on shipping skids and wrapped for protection.
2. Circuit breakers and breaker accessories shall not be shipped inside their respective compartments.
3. Compartments shall be provided with additional removable stays and braces designed to enable the compartments to withstand any forces of deformation

encountered up to and including movements to install the switchgear on its final installation pad.

4. Bus bars with associated hardware for connections between shipping groups/splits shall be shipped inside one of the groups/splits in which it shall be installed.

5. Shipping splits shall contain accessories to permit handling by cranes.

6. Where cranes are not available it shall be possible for splits to be skidded into final positions on rollers and using jacks to raise and lower.

D. Contractor shall store the switchgear and associated equipment in accordance with manufacturer's recommendations.

1. Store all equipment in clean, dry space.

2. Maintain factory protective wrappings or cover with heavy canvas or plastic to keep out dirt, water and construction debris.

3. Within 24 hours of receiving the switchgear, the Contractor shall install temporary heaters to prevent condensation during storage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools and supplies with the switchgear and associated equipment, neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

D. Furnish in addition the following spare parts:

1. One (1) set of complete replacement of power fuses for each switchgear assembly.

2. One (1) set of complete replacement indicating lamps for each switchgear assembly.

3. One (1) set of complete replacement color caps lamps for each switchgear assembly.

4. One (1) of each type of protection relay for each switchgear assembly.

5. Two (2) complete sets of fuse replacements of each rating and type installed as part of potential transformer primary and secondary for each switchgear assembly.

6. Two (2) complete sets of fuse replacements of each rating and type installed as part of control power transformer primary and secondary for each switchgear assembly.
7. One (1) spare breaker for each size provided.
8. Two (2) complete sets of control power plug/socket assemblies for each size breaker provided.
9. Four (4) complete sets of power connectors for each size breaker provided.

E. Furnish the following protective equipment and tools:

1. The Contractor shall furnish one (1) sets each of protective equipment and tools at each location in which Medium-voltage switchgear will be installed.
2. Protective equipment shall consist of:
   a. Flash Coat shall be 6oz. NoMex minimum with Velcro fasteners
   b. Arc Hood shall be rated 75 cal/cm^2 with UV and Infrared Protection
   c. Rubber Gloves shall be rated minimum 40,000V with leather protection.
   d. Face Shield shall be rated 7.33 cal/cm^2
   e. Safety Helmet
   f. Safety Glasses
   g. Carrying case for the above equipment
3. Protective tools shall consist of:
   a. Grounding Stick
   b. Voltage Tester
   c. Hot Sticks
   d. Grip All Clamp Stick
   e. Grounding Clamps, Ball and Socket ASTM Type 1, Class A, Grade 5
   f. Ground Stud Covers.

F. Furnish the following tools:

1. Two (2) sets of specialized wrenches and tools as required for proper installation, operation and maintenance.

2. One (1) infrared inspection system for thermo-graphic inspection of the power cable terminations or bus connections with the door closed.
3. Two (2) breaker lifting devices or transfer trucks with electric remote racking capability and switchgear mounted lifter.
4. Two (2) sets of drawout device extension rails. Rails shall be capable of being made integral to the switchgear cubicle and/or breaker transfer truck.
5. Two (2) sets of test plugs and cables for testing the controller while removed from the compartments.
6. One (1) test stand capable of accommodating each size breaker provided.
7. Two (2) lever's for manually racking and charging the breaker.
8. One (1) Levering Crank for moving the breaker between test and connected positions.
9. One (1) Breaker Lifting Yoke used for attachment to breaker for lifting breaker on or off compartment rails.
10. One (1) Ramp for rolling breaker mounted in lower compartment directly onto the floor.
11. One (1) "Dockable" transport dolly for moving breaker about outside its compartment.
12. One (1) Electrical levering device.
13. Remote Racking Device and Switchgear mounted lifter.
14. Furnish test kits to allow protection relay testing without removing system wiring.
    a. Provide test kit for each relay type, if different test kits are required.
    b. Alternatively provide one test kit for any group or number of relays.

G. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance.
    a. Replace all lubricants used during start-up and testing prior to acceptance of equipment.
    b. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

1. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchgear equipment shall be as manufactured by:
   1. Schneider Electric, Andover, MA;
   2. ABB, New Berlin, Wisconsin;
   3. Or approved equal.

B. Protection Relays shall be as manufactured by:
   1. GE
   2. Basler
   3. SEL
   4. Siemens
   5. Or approved equal.

C. Ball grounding studs and covers shall be as manufactured by:
   1. AB Chance, Centralia, MO;
   2. Or approved equal.

D. Ground cable set for use with ball studs shall be as manufactured by:
   1. AB Chance, Centralia, MO;
   2. Or approved equal.

E. Infrared thermometers shall be as manufactured by:
   1. Fluke Phoenix, AR;
   2. Or approved equal.

F. Infrared monitoring windows shall be as manufactured by:
   1. Fluke Phoenix, AR;
   2. Or approved equal.

G. Key Interlock systems shall be as manufactured by:
   1. Kirk Key Interlock Company LLC, North Canton, OH;
   2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Switchgear Ratings

1. 15 kV Switchgear shall have the following ratings and arrangements

a.	Nominal Voltage		13.2 kV
b.	Frequency		60 Hz
c.	Bus arrangement		
	1)	Phase	3 wire
	2)	Neutral	None
	3)	Ground	1
d.	System Grounding		Low resistance.
e.	Listings		
	1)	UL as applicable to components.	
	2)	ANSI for switchgear.	

B. General Arrangement

1. The entire switchgear assembly enclosure shall be NEMA 12.
2. All breaker, devices and accessories shall be powered by 125 VDC.
3. Metal-clad switchgear assemblies shall be comprised of vertical sections mechanically and electrically connected to form a complete switchgear assembly.
4. All metal work shall be free from burrs and sharp edges.
5. All connections and servicing shall be facilitated by front and rear access only.
6. The switchgear assembly shall be dead-front on all sides.
7. The switchgear assembly shall be suitable for bolting to floor sills.
8. The switchgear assembly shall be designed to prevent entry of vermin, dust, dirt, liquids and other agents which are detrimental to its operation.
9. The switchgear assembly shall be suitable for lifting by crane and be capable of being moved by use of jacks and rollers.
10. The switchgear assembly shall be capable of extension from either end without modification to existing structural members.

11. The switchgear assembly shall include the number of vertical sections and be arranged as shown on the Contract Drawings.

12. Structural or formed steel lifting beams for lifting any shipping split of the switchgear shall be supplied by the Contractor.

    a. These beams shall be sufficiently rigid to distribute evenly all strains which may be imposed in handling.

13. The switchgear shall be designed, constructed and installed in conformance with the seismic requirements of the Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

14. The switchgear shall meet the requirements of the Con Edison Specifications EO-2022 and coordinate with Section 26 13 10 – Service Entrance Medium-Voltage Cast Coil Transformers, Section 26 13 11 – Service Entrance Switchgears (SES), Section 26 11 16 – Secondary Unit Substations.

C. Structure

1. Each vertical section shall be a self-supporting structure consisting of a bolted or welded steel frame with reinforcing gussets.

    a. Front and rear doors, top and side covers shall be assembled on this frame.

    b. All covers and doors shall be 11-gauge steel minimum.

2. Each vertical section shall consist of one or two compartments arranged vertically.

    a. Each compartment shall contain a draw-out breaker or draw-out potential and control power transformer.

    b. One front and one rear door shall be mounted on each vertical compartment, bolted panels are not acceptable.

    c. Each compartment door shall be provided with a full-length hinge, door stop, hex-knob closing screws, hand operated closing latches and provisions for padlocking.

    d. Doors shall have a minimum 105 degree opening and be so designed that there will be no interference with devices when closed or when circuit breakers are inserted for removed.

    e. The control, instrumentation, and protection devices associated with the breaker in the compartment shall be mounted on the front compartment door of the same breaker.

f. Terminal blocks, fuse blocks, and some control devices may be mounted inside the compartment on the side panels.

3. When it is not possible to install all the equipment shown on the one line diagram in one breaker compartment an auxiliary compartment shall be furnished.

a. The auxiliary compartment shall have no provision for accepting a circuit breaker and shall be used to house equipment such as potential transformers, surge arresters, control power transformers, etc., as required.

4. The stationary primary contacts shall be tin-plated and recessed within insulating tubes.

5. A steel shutter shall automatically cover the stationary primary contacts when the breaker is in the disconnected position or out of the compartment.

6. Provide rails to allow withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device.

7. Circuit breakers shall be roll-out design.

D. Main Bus and Supports

1. The main bus shall be copper and have non-hydroscopic fluidized bed epoxy flame-retardant and track-resistant insulation.

2. Slip on sleeve type insulation is not permitted.

3. The rated current carrying capacity at the rated ambient temperature shall not be derated for conditions such as skin and proximity effects.

4. Where applicable the buses for service switchgear shall comply with the NYCEC.

5. The bus supports between units shall be flame-retardant, track-resistant, glass polyester for 15-kV class.

6. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand the magnetic stresses that would be produced by currents equal to the momentary (close and latch) and interrupting ratings of the circuit breakers.

7. All bus connections shall be rated to carry the rated continuous current, tapered busses are not permitted.

8. A set of insulated copper main bus, sized as shown on the Contract Drawings, shall be provided and have provisions for future extension.

9. All bus joints shall be silver plated, bolted with at least four (4) bolts per joint and insulated with easily installed boots.
10. The manufacturer shall provide in the form of table or similar arrangement the bolt torque values and instruction for all bus joints, taps and splices in the switchgear assembly, inclusive of values and instruction for outgoing and incoming feeder stabs.
11. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.
12. Expansion joints shall be provided to prevent undesirable or destructive mechanical strains in/at bus supports over the ambient temperature range negative 30 degree C to plus 50-degree C.
13. Access to bus bars shall be through removable panels in the front or back of the switchgear only.
14. Bus phase rotation shall be A-B-C.
15. Bus phasing shall be identified A, B, and C from top to bottom, front to back, and left to right, as viewed from the front of the equipment.

E. Ground Bus and Bus Grounding

1. A copper ground bus, measuring at least 1/4 X 2 inch in cross section shall extend the entire length of the switchgear and shall be bolted to each vertical section and to each breaker ground contact.
2. The ground bus shall have momentary and short-time ratings equal to that of the main bus.
3. All switchgear equipment requiring grounding shall be connected to the ground bus.
4. The ground bus shall be extended into each outgoing and incoming cable compartment for convenient field connection of cable shields.
5. The station ground-connection points shall at a minimum be located at each vertical end section.
6. The station ground-connection points shall be ground pads or other means shown on the Contract Drawing or acceptable to the Engineer.

F. Ground & Test (G&T) Device

1. The G&T device shall be manufactured to occupy the same cubicle normally occupied by the switchgear.

2. The G&T device shall be locked in an Engineer approved storage cubicle when not in use.
3. The G&T device shall be rated to meet all voltage and current requirements as the switchgear except for the fault interrupting rating.
4. The G&T device shall be equipped with a key interlock system to allow for grounding and testing of the Utility's primary service feeders.
5. Facilities shall be provided to operate (trip and close) the G&T device from a remote position by a twenty-five feet long extension cord with push-button controls.
6. To test the Company's primary service feeder, three, fully rated voltage test receptacles shall be provided on the front of the G&T device which provide individual connections to each phase of the LINE side of the G&T device. Testing of LOAD side equipment shall also be accomplished via fully rated, voltage test receptacles, which are key interlocked to ensure a safe operation.
7. All test receptacles shall be furnished with shutters to isolate the receptacles while not in use. The shutters shall be key interlocked with the manual operator in such a manner that they cannot be opened unless the G&T device is in the mode of operation assigned and the G&T device is closed (ground is applied). The key interlock shall allow the G&T device to be tripped open only after the test receptacle shutters are closed or after the test probes are inserted and locked into the receptacles. The test receptacles shall be interlocked with the operation of the G&T device to ensure that the probes can only be removed when the G&T device is in the ground position.
8. One set of test probes and with 25 feet long cables shall be furnished with each G&T device. The probes and cables shall be stored at the site. The cables shall have the same insulation voltage rating as the associated switchgear. The test cables shall be furnished with a lug for attachment to a test set.
9. The G&T device shall meet the Utility's requirements.

G. Wiring and Terminations

1. Compression lugs shall be furnished for all Medium-voltage cable terminations.
2. All Low-voltage wiring in the Medium-voltage parts of the switchgear shall be the shielded type with shield extending to the terminal blocks in Low-voltage compartments.

3. All secondary circuit wiring, including annunciator supervisory circuits and control shall Type SIS rated 600V, 90 degree C and not be smaller than No. 14 AWG.
4. Secondary wiring shall be armored where they pass through primary compartments.
5. PT circuit wiring shall not be smaller than No. 12 AWG and CT circuit wiring shall not be smaller than No. 10 AWG.
6. All wiring shall be neatly arranged and clamped securely to panels to prevent movement and breaking.
    a. Wiring clamps and supports at hinge transition points shall be properly sized to prevent chafing of insulation when the compartment door is opened or closed.
    b. Metal clamps must have insulating inserts between the clamps and wiring.
    c. Connection of cables, supports and cable harnesses to panels with adhesive shall not be acceptable.
7. Connections between shipping splits shall be arranged to require a minimum of field wiring.
    a. Terminal blocks shall be provided on one side of a shipping split break and coiled wires, properly tagged, shall be provided on the other side to facilitate these connections.
8. All secondary leads of each current transformer shall be wired directly to shorting type terminal blocks.
    a. Delta or Wye connections shall be made using jumpers on the load side of terminal block.
9. All wiring in the switchgear shall be labelled at each termination.
10. Terminals shall be identified with labels showing the terminal block and terminal number.
11. Terminal blocks shall be barrier type, with a marker strip down the center and shall be suitable for locking spade type terminal lugs.
    a. They shall be located a minimum of 10 in. from the base of the compartment.
    b. Each terminal shall be numbered or marked in a clear, easy-to-read manner with labels which refer to the designations used on wiring diagrams.

c. Parallel rows of terminal blocks shall be spaced a minimum of 6 in. on center.

d. Twenty percent spare terminals for all instrument and control wiring in each row shall be supplied by the Contractor.

e. Instrument transformer circuit grounds shall be made independently to the ground bus through a terminal block that is used for Purchaser's connections.

f. Only one ground connection shall be provided for each circuit.

12. Control wire including space heater AC power bus, P.T. leads, and C.T. leads shall be terminated using locking spade type lugs.

a. Wire splices and ring type wire lugs will not be accepted.

13. Compartments for spare breakers shall have complete wiring the same as defined for fully equipped spaces.

H. Circuit Breaker and Auxiliary Compartments

1. Circuit breaker compartments shall house a drawout circuit breaker element and include primary and secondary disconnecting contacts.

2. Each breaker compartment shall be complete with control switch and red, amber, and green indicating lights to indicate breaker position and that it has been tripped.

3. Indicating lights shall be the LED type.

4. Maximum mounting height of breaker control switches shall be 6'-6" above the bottom of the switchgear structure.

5. Grounded safety shutters shall automatically cover stationary contacts when the breaker element is withdrawn from the connected position.

a. Shutters shall be marked to show Bus or Feeder stationary contact positions and the position of the respective phases.

6. The draw-out type assembly shall be provided with a mechanical interlock to prevent moving the breaker into or out of the operating position unless the breaker is open.

7. The cable compartment shall be at the rear of the breaker compartment.

a. The design and arrangement of the compartment shall ensure sufficient space for terminating cables with IEEE Class 1 stress cones inclusive of minimum bending radii of the cables to be terminated, current transformers and other related components.

b. Horizontal barriers shall be provided to isolate circuit terminations when there are two breakers in the same vertical section.

c. Top or bottom conduit entries shall be provided as indicated on the Contract Drawings.

d. Connectors for terminations shall be furnished by the Contractor.

8. Where shown on the Contract Drawings the compartment shall be suitable for terminating non-segregated phase bus duct.

9. Current transformers shall be located over the primary insulating· tubes in the breaker compartment.

a. They shall be accessible from the front to permit changing transformers when the unit is de-energized.

10. Zero sequence current transformers shall be provided as shown on the One Line Diagram.

a. Zero sequence current transformer shall be installed so that its opening is clear for easy installation of field cables.

b. Field drilling of holes in supports is not acceptable.

11. Auxiliary compartment shall be used to mount potential transformers with fuses, surge arresters, control power transformers, etc.

a. Where rollout trays are provided to mount potential or control power transformers, the movable carriage shall be equipped with primary and secondary disconnecting devices, grounding devices and a safety barrier.

b. Auxiliary compartments shall be furnished when all auxiliary equipment cannot be accommodated in the breaker unit.

12. Circuit breaker and auxiliary compartments shall be equipped with space heaters.

a. Each space heater circuit shall be rated for 240VAC and operated via fused circuits from the 120 VAC power bus and shall be wired through a breaker truck auxiliary switch.

b. Heater circuits shall be energized when the breaker is open or is removed from operating position.

c. Heaters shall be wired from temporary connections when the switchgear is in storage.

I. Circuit Breakers

1. All circuit breakers shall be vacuum interrupter, horizontal draw-out type, provided with self-aligning, bus-side and load-side disconnecting devices (disconnecting fingers) and the following ratings:

a.	Rated Ambient Temperature	40 degrees C
b.	Frequency	60 Hz
c.	No of poles	3
d.	Rated Maximum Voltage	15 kV
e.	Rated BIL	95 kV
f.	Rated Current	1200 A
g.	Rated Short-Circuit Current at maximum rated kV.	40 kA
h.	Closing and Latching Capability	130 kA
i.	Short Time Rating	40 kA
j.	Rated Interrupting Time	3 cycles

2. All breakers of the same rating shall be electrically and mechanically interchangeable and fit any breaker compartment of the same rating.
   a. Compartments shall be interlocked or draw-out mechanisms designed with coded plates to prevent insertion of incorrectly rated breakers.
   b. Grounded-steel protective front covers on the breaker truck shall be provided to prevent access to the operating mechanism or live parts both DC and AC when the compartment door is opened.
3. All breakers shall be electrically operated by a motor-charged, heavy-duty spring-type stored-energy mechanism.
   a. After the circuit breaker is closed, the motor shall charge the closing springs for subsequent operation of the breaker.
   b. The stored-energy mechanism shall be automatically discharged prior to the circuit breaker being withdrawn from or inserted into its compartment.
   c. The electric motor shall be a universal motor rated at 125 VDC and shall operate from 90 to 140 VDC.
   d. The stored energy closing springs shall be suitable for manual as well as electrical charging.

e. Breakers shall be mechanically and electrically trip-free in all positions.

f. Circuit breakers shall be equipped with an anti-pumping feature.

4. Each circuit breaker shall be furnished with mechanical indicators for:

   a. Positive indication of breaker open or closed position

   b. Breaker closing spring charged or discharged position

   c. Positive indication of breaker position, i.e. connected test, or disconnect

   d. To prevent the circuit breaker from being racked in or out unless the breaker is open.

   e. To prevent closing the breaker by any means while it is being racked in or out.

5. Each circuit breaker shall be furnished with a sufficient number of auxiliary switch contacts (52 AUX), mechanism operated switch contacts, (52 MOC) and truck-operated switch contacts (52 TOC) to provide all necessary interlocks for proper operation of connected equipment including remote and local positions.

   a. All auxiliary switch contacts shall be field reversible.

   b. All auxiliary, mechanism, truck-operated and spare contacts shall be completely wired to terminal blocks whether in immediate use or not.

   c. All breakers of the same rating shall have the same number of auxiliary, mechanism, truck-operated and spare contacts.

   d. The following minimum contacts on each switch shall be provided:

      1) 52 AUX, 3 NO and 3 NC

      2) 52 MOC, 3 NO and 3 NC

      3) 52 TOC, 3 NO and 3 NC

6. Trip and close levers for manual operation shall be furnished on the circuit breaker element.

7. When the circuit breaker is in the test position, control circuits shall permit local operation of the breaker.

   a. Circuits for remote operation of the breaker shall be disconnected when the breaker is in the test or disconnect position.

b. The breaker shall have provision for padlocking in the test and disconnect positions.

c. When padlocked in the disconnect position the breaker element shall be locked in the compartment.

8. Circuits used for energizing space heaters and for interlocking with other electrically operated circuit breakers and wired through "b" auxiliary contacts shall be maintained automatically in the disconnect position of the circuit breaker.

9. Grounding of the circuit breaker base shall be automatically applied before primary contacts are made and shall be maintained until the primary contacts have been separated by a safe distance.

10. A suitable mechanism for manually inserting and withdrawing the removable element shall be provided for each circuit breaker.

a. The mechanical advantage ratio of the mechanism shall be such that the device may be operated easily by one person.

J. Protective Relays

1. Features Applicable to all Protective Relays.

a. The Contractor shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the Contract Drawings and specified in this Section.

b. Protective Relays shall be solid-state, microprocessor-based, multi-functional type that operates from the 5-ampere secondary output of current transformers and the 120 VAC secondary output of potential transformers.

c. Alternating-current devices, instruments and relays shall be suitable for operation from 5 amp current and 120V potential circuits at 60Hz.

1) They shall not be injuriously affected by primary short circuit current rating of the assembly.

2) All devices, instruments and relays shall be accurately adjusted and calibrated before shipment.

3) The arrangement of equipment on the front of the switchgear panel shall be subject to approval by the Engineer.

d. Protective relays shall be equipped with semi flush mounted cases, totally withdrawable, with integral test facilities and automatic

current transformer shorting with sequenced disconnect, and conform to ANSI C37.90.

e. Static relays shall be qualified for surge withstand capability (SWC) in conformance with ANSI C37.90.

f. Control relays shall be designed to relieve control and auxiliary switches of interrupting currents above their rating.

1) The control arrangement equipment shall be such that a maintaining contact may be used if desired.

2) Two spare control relays with 125VDC coil and four normally open and four normally closed contacts shall be provided and completely wired to terminal blocks.

g. Alarm relays shall be installed to monitor 125 VDC power supply to circuit breaker control circuit, to provide input to remote alarm should the power supply fail.

h. Instrument and relay phasing shall be left to right or top to bottom with neutral relays underneath phase grouping.

i. Where possible, relays shall be mounted above the control switch on their respective panels.

j. Relays shall be located as close as possible to the respective switches and shall be placed at a height convenient for adjustment by a worker standing on the floor.

k. The manufacturer shall furnish and install all contacts, relays, switches, etc. required for proper operation, per the Contract Drawings, Specifications and as required.

l. “Lead seals” shall be installed on all relays after they has been installed, commissioned into service and accepted.

m. All relays shall be set based on studies as described in Section 26 05 73 – Power System Studies.

n. The Contractor shall test and calibrate each protective relay in accordance with the manufacturer’s recommendation, power system studies and best industry practice.

o. Trip circuit monitoring is required for all circuit breakers and the associated lockout relays.

p. The Contractor shall provide active standby (second) protective relay with the same protective functions for both main breakers

protection. The active standby protective relay shall be wired such that the loss of one relay shall not interrupt the protective functions of the second protective relay. Loss of one protective relay shall initiate an alarm at the annunciator panel and remote location.

2. Microprocessor Protective Relays

   a. Microprocessor Protective Relays shall be multifunction type incorporating multiple IEEE C37.2 device functions in a single device.

   b. The device functions shall be as shown on the Contract Drawings or as determined by Section 26 05 73 – Power Systems Studies.

   c. The relays shall provide protective functions for each of the three (3) phases, neutral and ground as shown on the Contract Drawings.

   d. The relays shall be true RMS sensing of each phase and ground.

      1) Ground element shall be capable of being utilized in residual, zero sequence, or ground source connection schemes, or deactivated.

   e. The primary current transformer rating being used for phase and ground protection feeding the device shall be programmable for current transformers with primary current ratings from 5 through 5,000 amperes.

   f. Both the phase and ground protection curves shall be independently field selectable and programmable with or without load.

   g. Curves shall be selectable from the following:

      1) IEEE: Moderately inverse, very inverse, extremely inverse

      2) IEC: A, B, C or D.

      3) Thermal: Flat, It, I^2t, I^4t

   h. Thermal curves shall be similar to those on Low-voltage trip units for close coordination with downstream devices.

   i. Selectable short time delay pick-up and short time delay time settings shall also be provided.

   j. Phase instantaneous over-current trip shall have field programmable pick-up points from 1.0 to 25 times current transformer primary rating or NONE.

1) In addition, a field selectable (ON or OFF) discriminator circuit shall be included such that when phase instantaneous over-current has been programmed to NONE, the discriminator circuit shall protect against currents exceeding 11 times current transformer primary rating, only when the breaker is closed.

k. The relays shall be field configurable to have either of the following function combinations assigned to type "a" contacts:

1) one contact assigned ANSI 51 phase and ANSI 51 ground and the other contact assigned ANSI 50 phase and ANSI 50 ground;

2) one contact assigned ANSI 51/50 phase and the other contact assigned 51/50 ground.

l. The relays shall have a built-in alphanumeric display capable of displaying the following information with metering accuracy of plus/minus one (1) percent of full scale (I_n) from 0.04 X I_n to 1 X I_n and plus/minus two (2) percent of full scale (I_n) from 1 X I_n to 2 X I_n:

1) Individual phase currents and voltages.

2) Ground current and voltages.

3) Cause of trip.

4) Magnitude and phase of current or voltage causing trip.

5) Peak current and voltage demand for each phase and ground since last reset.

6) Current and potential transformer primary rating.

7) Programmed phase and ground set-points.

m. The relays shall have the following features:

1) Integral manual testing capability for both phase and ground.

2) Zone selective interlocking capability for short time and ground fault protection.

a) This function shall be provided and factory wired.

b) Where zone selective interlocking is not an integral part of the protective device, a full bus differential scheme shall be required for both phase and ground

in addition to specified time over-current and instantaneous over-current phase and ground fault protection.

c) Bus differential scheme shall be provided with separate differential current transformers for all incoming and out-going loads, as well· as appropriate differential relays (ANSI 87 and 87G) as approved by the Engineer.

3) Continuous self-testing of internal circuitry.

4) Unit failure alarm contact for customer use.

5) Programmable lockout/self-reset after trip function.

6) Programmable set-points for device curve selection.

7) Programmable inputs, such as current transformer ratios.

8) Access to program and test modes shall be via sealable hinged cover for security.

9) The relays shall be suitable for operating temperatures from -30 degrees to 55 degrees C. Relay and relative humidity from 0 to 95% non-condensing.

10) The relays shall have the communication capability via local area network compatible to the electrical monitoring system.

11) Relays shall be capable of the following over the communication network:

a) Ability to transmit all information contained in the relay such as currents, set-points, cause of trip, magnitude of trip current, and open- close trip status.

b) Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is dip switch configured in remote close/open mode.

12) Relays alarm and/or trip contacts shall not change state if power is lost or an under-voltage occurs.

a) These contacts shall only cause a trip upon detection of an over-current or fault condition based upon programmed settings.

13) The relays shall be suitable for operating on control power with a nominal input voltage of 125 volts DC.

n. The relays shall provide for complete real time monitoring and metering functions. These shall include:

1) A fault locator with a record of the last 10 faults.

2) An event recorder with a record of the last 128 events.

3) Waveform capture with storage of 128 cycles of data.

4) A power simulation feature shall be included to allow testing without the need for external voltage and current inputs. User interfaces shall include:

5) A 40-character display and a keypad.

6) Indicator LEDs on the front panel which shall provide a quick visual indication of status.

7) A front panel RS232 serial port, which shall provide easy computer access.

8) Two (2) rear RS485 ports, one of which can be configured as a RS422 port.

o. The relays shall include the following user interfaces:

1) A LED display, control keys and full numeric keypad located on the front panel.

2) LED indicators located on the front panel which shall indicate the status of the protection relay, generator, and output relays.

3) An RS232 port located on the front panel with a baud rate of 9600 bps.

4) Two (2) RS485 ports located on the rear of the unit with baud rates from 300 to 19,200 bps.

5) The communications ports shall allow simultaneous independent access using Modbus® RTU and DNP 3.0 protocol.

6) Windows® based PC software which enables setpoint programming, file storage, on-line help, and real time display of status and measured data.

3. Feeder Management Relays

a. Feeder management shall be provided using multifunction-microprocessor relays complete with protection, metering, and monitoring functions.

b. The feeder management relays shall provide primary protection and management of distribution feeders. Protection shall include:

1) Time overcurrent.

2) Instantaneous overcurrent.

3) Directional overcurrent.

4) Undervoltage and overvoltage.

5) Negative sequence voltage.

6) Undervoltage automatic restoration.

7) Bus under frequency.

8) Under frequency automatic restoration.

9) Control shall include

a) manual close controls

b) cold load pick-up control

c) four (4) settings groups

d) 20 programmable logic inputs

e) two (2) breaker control relay outputs

f) one (1) internal failure relay output

g) five (5) programmable relay outputs

h) one (1) solid state trip output, and

i) eight (8) analog transducer outputs.

4. Transformer Management Relays

a. Protection for power transformers shall be provided by a highspeed multi-processor multi-function-based relay.

1) The following protection functions shall be included:

2) Three phase differential current relays with dual slope percentage differential restraint and harmonic restraint.

3) Unrestrained differential overcurrent.

4) Two (2) instantaneous overcurrent elements for each phase winding, calculated neutral, and ground current.

5) One (1) time overcurrent element for each phase winding, calculated neutral, and ground current.

6) Negative sequence overcurrent.

7) Under frequency and rate-of-change elements for load shedding.

8) Over frequency element.

9) Overexcitation to protect against overvoltage and over fluxing.

b. Enhanced flexibility of the protection system shall be provided by the following:

1) Auto-configuration of transformer CTs to wye configuration.

2) Programmable protection logic to allow any combination of protection elements, logic inputs, and timers to be assigned to any output.

3) Adaptive harmonic restraint to prevent false tripping during inrush offers three (3) programmable restraint methods.

4) Multiple set point groups.

5) Dynamic CT ratio mismatch correction.

6) Adaptive time overcurrent curves which take into account the transformer capability when supplying non sinusoidal load currents.

c. The following inputs and outputs shall be provided:

1) 16 logical inputs.

2) One (1) analog input (optional).

3) One (1) high speed electronic output.

4) Eight (8) electro-mechanical relay outputs.

5) Seven (7) analog output channels (optional).

6) An IRIG-B input.

d. Logic shall be provided to define configurable outputs.

5. Individual Protective Relays.
   a. Relays for specific protective functions where shown on the Contract Drawings, which are not incorporated in the Feeder Generator or Transformer relays described in this Section shall have the following features:
      1) Microprocessor based control functions.
      2) Front mounted potentiometers, settings for pick-up and drop-out values, timing values, etc.
      3) 125 VDC control voltage.
      4) Output contacts.
      5) Target indicators.
      6) Push-to-energize output switches for testing purposes.
      7) Surge withstand capability per ANSI/IEEE C39.90.1-1989, Surge Withstand Capability Test.
6. Lockout Relays
   a. Lockout relays (Device 86) shall be heavy-duty, multi-contact type with pistol grip handle control switch.
   b. The mechanical target on the escutcheon plate assembly shall indicate relay position.
   c. Reset position shall be indicated by a black target and tripped indication shall be by an orange target.
   d. Coil voltage shall be 125 VDC.

K. Instrument Transformers
1. Current and potential transformers shall be furnished for the switchgear relays, breakers, meters and transducers, and for converting bus voltage to appropriate control voltages.
2. Current and Potential transformers shall comply with IEEE C57.13
3. There shall be two (2) separate sets of transformers for each circuit breaker circuit.
   a. One set shall be used exclusively for relaying circuits and the other set shall be used exclusively for metering circuits.

4. The current and potential transformers shall have accuracy Classes confirming to IEEE C57.13 unless the Electric Utility has detailed specific requirements.
5. Ring type current transformers shall be furnished as indicated on the Contract Drawings.
6. The thermal and mechanical ratings of the current transformers shall be coordinated with the momentary current rating of the circuit breakers.
7. The standard location for the current transformers on the bus side and load side of circuit breaker units shall be front accessible to permit adding or changing current transformers without removing Medium-voltage insulation connections.
8. Shorting terminal blocks shall be furnished on the secondary of all the current transformers circuits.
9. Potential and control power transformers of the quantity and ratings shall be supplied as indicated on the Contract Drawings and as required.
10. Potential transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment.
11. Control power transformers up to 15 kV, 15 kVA, single-phase shall be mounted in drawout drawers.
12. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement.
    a. Shutters shall isolate primary bus stabs when drawers are withdrawn.
13. A mechanical interlock shall be provided to require secondary breakers to be open before potential and control power primary fuse drawer can be withdrawn.

L. Metering, Monitoring and Communications

1. Provide customer metering, monitoring and communication devices where shown on the Contract Drawings.
2. Customer metering monitoring and communication installed in Medium-voltage metal-clad switchgear shall comply with the requirements of this Section.
3. Provide a separate customer metering compartment with front hinged doors.
4. Customer metering compartments shall as applicable:

a. Comply with the General Arrangement requirements detailed under this Section.

b. Comply with the Structure requirements detailed under this Section.

c. Comply the Main Bus and Supports requirements detailed under this Section.

d. Comply with the Ground Bus and Bus Grounding requirements detailed under this Section.

e. Comply with the Wiring and Termination requirements detailed under this Section.

f. Comply with the Circuit Breaker and Auxiliary Compartments requirements detailed under this Section.

5. Customer metering, monitoring and communication shall be supplied by separate metering current transformers as shown on the Contract Drawings.

6. Customer metering, monitoring and communication shall be supplied by separate metering potential transformers as shown on the Contract Drawings.

M. Fully-Equipped and Spare Compartments

1. Compartments designated as spaces for future breakers on the Contract Drawings shall be provided with complete wiring, terminal blocks, and mounting provisions for future breakers, including current transformers, metering, all outgoing wiring for future remote breaker control, alarm, and indication.

2. Two (2) 12-point terminal blocks shall be provided as spares.

3. Drilling provisions for switches, meters, etc. on compartment doors are not required.

4. Compartments designated as spaces for spare breakers shown without current transformers and metering shall have complete wiring the same as defined for fully equipped spaces.

5. Compartments designated as spaces shall not contain any equipment.

N. Circuit Breaker Test Cabinet

1. One Test Cabinet shall be furnished for inspection and test of the removable vacuum circuit breaker elements.

2. The Test Cabinet shall be furnished with a control switch and indicating lights to permit operating the breaker electrically from the cabinet and shall also include a plug and cable for connection to the breaker.

3. The Test Cabinet shall be mounted within the facility housing the switchgear or as shown on the Contract Drawings and be completely wired.

O. Key Interlock Systems

1. Key interlock systems shall be provided as indicated on the Contract Drawings and as specified herein.

2. Key interlock systems shall be designed and arranged as shown on the Contract Drawings to enable or prevent the paralleling of multiple utility sources or multiple feeders which are normally connected to the switchgear busses.

3. Contractor shall furnish and install the interlock components at each switchgear to ensure the completeness and satisfactory operation of each system as shown on the Contractor Drawings.

4. Where applicable the Contractor shall comply with Electric Utility requirements for key interlock system installed on the switchgear lineups.

5. There shall be clear access to all key interlocks.

6. Wires shall be routed such that they do not hinder the clear access to the key interlocks.

P. DC Control-Voltage System

1. The Contractor shall furnish and install a Central Battery System to power the 125 VDC Control-Voltage System from which all breakers, control, protective and accessories devices shall operate.

2. The layout of the DC Control-Voltage System shall be as shown on the Contract Drawings.

3. The Central Battery System shall be as detailed in Section 26 33 23 – Central Battery System.

4. The Central Battery System and the DC Control-Voltage System shall comply with the Electric Utility requirements

Q. Arc Flash Mitigation

1. The Switchgear shall be equipped with energy-reducing arc flash mitigation system. The Switchgear shall have Arcflash Reduction Maintenance System with integral selector switch with (5) five arc-flash reduction settings.

2. The Contractor shall provide Switchgear arc energy reduction system documentation to the Engineer.

R. MV Switchgear Mimic (Breaker Remote Control) Panel

1. MV Switchgear Mimic Panel (Breaker Remote Control Panel)

a. The Contractor shall furnish and install a stand-alone MV Switchgear Mimic panel as shown on the Contract Drawings to provide remote control for the switchgear breakers.

b. Remote Mimic Panels shall be installed as shown on the Contract Drawings.

c. Remote Mimic Panel shall have the switchgear single line diagram shown graphically.

1) The graphic display shall include the bus and each breaker.

2) Nameplates shall identify each breaker number, the load it feeds, etc.

d. The switchgear breaker controlled at the Remote Mimic Panel shall include a breaker control switch, green, red and amber indicating lights to display that the breaker is open, closed or tripped, respectively.

e. The Contractor shall submit all details of the mimic panels including the display, equipment layout, wiring, and materials, for Engineer approval.

f. Arc Flash Study submittals shall demonstrate that operations at the Remote Mimic Panels do not represent a direct exposure to arc blasts energies from the front or rear of the switchgear lineup for any of the controlled breaker.

g. A panel mounted alarm annunciator shall be included for monitoring and display of the various trips, trouble, and alarm points as shown on the Contract Drawings.

h. All indicator lamps shall be low burden LED type with power taken from the same source as the switchgear.

i. All breaker control switches shall be of the same make and model as used on the switchgear.

2. Annunciator:

a. The annunciator alarm points and engraving shall be in accordance with the alarms shown on the Contract Drawings. Spares shall not be engraved.

b. The annunciator shall activate module flashing light and sound alarm horn, when an alarm condition occurs. When the acknowledge pushbutton is depressed, annunciator shall change flashing light to steady light and silence the horn. When the alarm condition is corrected, annunciator shall automatically turn off the steady light.

c. The annunciator shall include the following requirements and features:

1) Flush mounted within the breaker control panel enclosure. Logic shall be solid state integral, suitable for operation at 125-volt DC from the DC power system.

2) Plug-in lamp modules and alarm logic circuit boards for each point including spares. ISA sequence alarming with adjustable time delay for each field contact status transfer.

3) Repeat relays with isolated auxiliary contacts, which follow each alarm point.

4) Front selector switches for NC/NO field contacts and lock-in /non-lock-in alarms.

5) Yellow lamp-test and acknowledge pushbuttons.

6) Horn with adjustable volume control.

7) Single alarm point per window with two (2) lamps per point. Window size shall be 3-inch by 3-inch nominal.

d. Common Alarm Circuitry:

1) The alarm circuitry required shall be activated when any one (1) of the annunciator points is in alarm to remotely signal a common alarm.

2) The repeater relay isolated auxiliary contact, one (1) from each annunciator point, shall be wired to a common alarm relay with two (2) sets of form C contacts. The common alarm relay shall be suitable for operation from the same 125-volt DC supplying the annunciator.

3) The circuitry shall include an Auto-Off-Test selector switch, control panel mounted, for controlling the remote alarm

operation. In auto mode, the common alarm relay shall energize whenever the annunciator alarms. In test mode, the common alarm relay shall energize and the annunciator alarms shall be bypassed. In off mode, the common alarm relay shall be de-energized.

4) The common alarm relay contacts shall be suitably wired to signal the remote horn/strobe alarm device at the station exterior.

S. Insulating Floor Mat

1. The Contractor shall furnish and install non-conductive floor mat in front of the Medium-Voltage Metal-Clad Switchgear to provide insulation for the workers.

2. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. Painting shall be in accordance with Section 09 91 90 – Painting.

2. All internal and external metal surfaces of the switchgear/s shall be thoroughly cleaned, rinsed and phosphatized prior to painting.

3. The switchgear shall be painted with a thermosetting electrostatically applied polyester powder with final baked on average thickness between 1.5 to 2.0 mils.

4. The color of all interior finishing coats shall be white.

5. The color of the exterior finishing coats shall be ANSI No. 61 grey.

6. The finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass ASTM B117 5% salt spray test for a minimum of 1000 hours.

7. A supply of touch-up paint shall be provided from paint used for the final coat.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Each switchgear lineup shall be completely assembled, wired and tested at the factory, including all buses, connections, insulator, terminals and terminal blocks, to demonstrate that it has been properly assembled,

properly lubricated, is not overheating, is not overloading and has no electrical or mechanical defects.

2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment.

3. Shop test shall be in accordance with the latest revisions of IEEE C37.20.2, IEEE C37.09 and shall demonstrate that the equipment tested conforms to the requirements specified.

4. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

5. Switchgear shop tests shall include the following:

    a. Breaker Testing

        1) All tests shall be in accordance with the latest version of IEEE C37.09.

        2) Alignment test to verify all interfaces and interchangeableness.

        3) Circuit breakers operated over the range of minimum to maximum control voltage.

        4) Factory setting of contact gap.

        5) One-minute dielectric test per IEEE standards on primary and secondary circuits with breakers open and closed.

        6) Operation of all wirings, relays and other devices verified by an operational sequence test.

        7) Five (5) mechanical operations tests of each breaker.

        8) Timing testing of all breakers.

    b. Switchgear Line up Tests

        1) Physical inspection shall be performed including torque tests of bus bolts.

        2) Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.

        3) Continuity test shall be performed on power and control wires.

4) Functional operations test which shall include pick up, dropout, time delay, sequence and polarity.

5) Primary hi-potential tests shall be performed.

a) Primary current carrying parts shall be tested between phases, phase to ground, and line to load.

b) The applied voltage shall be twice rated voltage plus 1000 for 1 minute.

6) Hi-Potential tests on control and secondary wiring shall be performed.

a) Control circuit wiring shall be tested for 1500 volts to ground for 1 minute.

c. Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation. Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests

3. For the Witnessed Shop Test, the Contractor shall perform all of the Certified Tests in the presence of the witnesses.

4. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

5. Switchgear shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Switchgear equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. Switchgear equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Switchgear equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

D. Steel channels shall be provided for support of switchgear equipment.

E. Switchgear equipment shall be securely mounted to mounting surface with anchor bolts.

F. Anchor switchgear to satisfy the specified seismic requirements in accordance with the anchorage details.

G. Install nameplates for identification of switchgear equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, switchgear shall be field tested for operation and conformance.
2. The Contractor shall perform field tests in accordance with this Section and Specifications.
3. The field tests shall be witnessed by the Engineer and certified by the Contractor.
4. Switchgear testing shall be performed by the manufacturer's representative, prior to energizing equipment.
5. Equipment shall not be energized without the permission of the Engineer.
6. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:
    a. Breakers and vertical sections shall be checked to determine that they have been properly installed, lubricated and connected.
    b. Control equipment and connections shall be checked to determine that they are not defective.
    c. Device settings and adjustments shall be verified.
    d. Mechanical and electrical interlocks shall be inspected and controls shall be checked for proper operation.
    e. Functional tests verifying the operations of all controls and displays.
    f. Infrared testing shall be performed once after initial energization of the switchgear and a second time after full load has been applied continuously for (24) hours.

B. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the switchgear, check the switchgear installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation and maintenance of the switchgear.

2. The Contractor shall provide switchgear equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

3. Minimum number of manufacturer's representative site visits per medium-voltage metal-clad switchgear:

Visit Type	Minimum Number of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation & Inspection	1	2	5
Field Tests	1	2	4
Acceptance Testing	1	2	3
Training	1	2	3

4. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

5. The Engineer shall have the right to reallocate any unused person-days.

6. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.

   a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction and all other pertinent information.

7. The service representative shall sign in and out with the Engineer on each day they are at the site.

a. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide switchgear Start-Up services and Training in accordance with this Section and the Specifications.

1. Acceptance Testing

a. The Contractor shall provide acceptance testing of the switchgear.

b. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.

c. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

1) Acceptance testing inspection shall be performed on each switchgear. Inspection shall include the following:

2) Physical, electrical and mechanical condition shall be inspected.

3) Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

4) Ventilating air passageways shall be inspected for blockage.

5) All connections shall be inspected for high resistance.

6) Electrical and mechanical interlock systems shall be checked for proper operation.

7) Insulators shall be inspected for evidence of damage or contamination.

8) Equipment shall be cleaned and lubricated as required.

2. Acceptance electrical testing shall be performed on each switchgear. Testing shall include the following:

a. Ground-resistance tests shall be performed.

b. Insulation-resistance tests shall be performed on each bus section, on each switch, transformer and circuit breaker, phase-to-phase and phase-to-ground.

c. An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

d. Contact-resistance test shall be performed.

e. Control and metering wiring performance test shall be performed.

f. Circuit breaker trip characteristics shall be determined by primary current injection.

g. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.

h. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Medium-voltage fuses. Medium-Voltage Fuses shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. Fuses shall be suitable for use with power circuits.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. Definitions

1. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at 1000 volts and below 99000 volts.

B. Reference Standards

Medium-Voltage fuses shall comply with the latest applicable provisions and recommendations of the following even if not specifically listed in this Section:

1.	IEEE C37.40	-	Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
2.	IEEE C37.41	-	Design Tests for High-Voltage Fuses, Fuse Disconnecting Switches and Accessories.
3.	IEEE C37.46	-	Specification for High-Voltage Expulsion and Current-Limiting Power Class Fuses and Fuse Disconnecting Switches.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. General

1. Medium-voltage fuses shall be designed, built, and tested in accordance with IEEE C37.40, 41 and 46.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's catalog cuts for the fuses proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.

2. Time-current curves for the fuses proposed for use.

B. Reports

1. Field Test Reports shall be submitted.

2. Manufacturer's site visit report shall be submitted.

C. Operation and Maintenance Manual

1. Operation and Maintenance Manuals shall be submitted in accordance with this Section and the Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Fuses shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Spares

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare fuses in accordance with this Section and the Specifications.

2. The spare fuses shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

3. Spare fuses shall include at a minimum the following:

a. Ten (10) percent of each rating used.

b. Minimum of three (3) of each rating.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Medium-voltage fuses shall be as manufactured by:

1. S&C Electric, Chicago, IL;

2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General:

1. Fuses shall be compatible with the system operating voltage shown on the Contract Drawings.

2. Medium-voltage fuse ampere ratings shall be as shown on the Contract Drawings.

B. Medium-voltage Fuses:

1. Medium-voltage fuses shall be current limiting type, unless stated in this Section and the Specifications to be expulsion type.

2. Current limiting type Medium-voltage fuses shall have a minimum of 85,000 RMS symmetrical ampere interrupting rating.
3. When boric acid expulsion type Medium-voltage fuses are used, interrupting ratings shall be as shown on the Contract Drawings.
4. Medium-voltage fuses used with interrupter switches shall be E rated.
5. Medium-voltage used with motor starters for motor protection shall be R rated.
6. Medium-voltage fuses shall be provided with a blown fuse indicator to signal operation of the fuse element.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Fuses shall be installed within equipment in accordance with the manufacturer's recommendations and industry standards.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Medium-Voltage Surge Protective Devices (MV SPDs).

B. MV SPDs shall be provided in accordance with the requirements specified under this Section and the Contract Drawings.

C. MV SPDs shall utilized to limit repetitive transient voltage and current surges in Medium-Voltage AC power circuits.

D. In general, Medium-Voltage Surge Protective Devices shall be provided in the primary side of all Medium Voltage, 15 kV Service Entrance Switchgears (SES), and other medium-voltage equipment.

E. The Contractor shall furnish all labor, materials, equipment, services, and incidentals necessary for the installation of the MV SPDs as specified herein.

F. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 53 - Identification for Electrical Circuits

B. Section 26 05 27 - Grounding

C. Section 26 08 11 - General Electrical Testing

D. Section 26 11 16 - Secondary Unit Substations

E. Section 26 13 10 - Service Entrance Medium-Voltage Cast Coil Transformers

F. Section 26 13 11 - Service Entrance Switchgears (SES)

G. Section 26 13 26 - Medium-Voltage Metal-Clad Switchgear

1.04 REFERENCES

A. Definitions

1. Medium-Voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 1,000-99,000 Volts Class.

2. All references to the AHJ (Authority Having Jurisdiction) shall mean the NYCEC.

3. All references to the Electric Utility or Utility shall mean Consolidated Edison Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

1.	ANSI/IEEE C84.1	-	Electric Power Systems and Equipment – Voltage Ranges (60 Hertz).
2.	ANSI/IEEE 141	-	Recommended Practice for Electric Power Distribution for Industrial Plants.
3.	IEEE 1100	-	Recommended Practice for Powering and Grounding Electronic Equipment.
4.	UL 1012	-	Power Units Other Than Class 2.
5.	UL 1283	-	Electromagnetic Interference Filters
6.	UL 1449	-	Surge Protective Devices 4th Edition or later.
7.	NEC	-	National Electrical Code.

1.05 DESCRIPTION

A. SPDs shall be Type 1, 2 or 3.as defined by UL 1449.

1. Type 1 SPDs shall be

a. Permanently connected and intended for installation between the secondary of the service transformer and the line side of service equipment.

b. Installed without use of external overcurrent protective device.

2. Type 2 SPDs shall be

a. Permanently connected and intended for installation on the load side of the service equipment overcurrent device.

3. Type 3 SPDs shall be

a. Permanently installed at the point of utilization.

b. Installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel.

c. Not used at the utilization point if the distance criteria of a. and b. above cannot be satisfied.

1.06 QUALITY ASSURANCE

A. MV SPDs shall be designed, built, and tested in accordance with the latest applicable editions of NEMA, ANSI/IEEE, UL and NFPA.

B. MV SPDs shall be UL listed.

C. MV SPDs of the types and ratings required are of those acceptable manufacturers who have been regularly engaged in the development, design, testing, listing, manufacture and servicing of MV SPDs for a period of ten (10) years or more and whose products have been in satisfactory use for ten (10) years or more.

D. MV SPD manufacturers shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

E. The Quality Assurance Program shall be the manufacturer’s standard program specifically dedicated to ensure each MV SPD is designed, assembled, and tested in accordance with the requirements specified herein.

F. Testing shall be done in accordance with UL 1449 on the complete MV SPDs with lead length comparable to that which will be required to connect the MV SPDs to the equipment to be protected and as shown on the Contract Drawings.

G. Only qualified personnel or licensed electricians shall install MV SPDs.

H. The Contractor shall retain the services of the MV SPD manufacturer for field service.

I. Field service shall be in accordance with the requirements specified under this Section and the Specifications.

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

1. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory installation and operation.

2. Catalog cuts indicating selected ratings and mechanical drawings of MV SPDs, shall be submitted for approval by the Engineer.

3. Submittals shall contain the required published device specifications and Drawings to show conformance with all parts of this Section.

4. Instructions for installation and connection shall be provided with the MV SPDs.

5. All Let-Through voltage data shall be measured on an "As Installed" lead length basis, simulating actual installation. At the module or at the bus "Zero lead length" data is not acceptable.

6. Copy of the ISO 9001:2008 Certificate of Registration will accompany the submittal.

7. The connection lead length from the MV SPD enclosure to the connection point of protected circuit must be detailed in the submitted documentation.

B. Report Submittals:

1. Medium-Voltage Surge Protective Device (MV SPD) shop test reports shall include test data verifying let-through voltage, surge current rating and noise attenuation.

2. Manufacturer’s field report

3. Surge Life (Repetitive Surge) rating

4. Maximum Continuous Operating Voltage (MCOV) rating

5. Voltage Protection Ratings for all modes (VPR)

6. Nominal Discharge Current (I_n)

C. Operation and Maintenance (O&M) manuals shall be submitted for approval.

D. Bill of Materials

1.08 DELIVERY, STORAGE, AND HANDLING

A. MV SPDs shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer’s recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. MV SPDs shall be as manufactured by:

1. ASCO Power Technologies, Clearwater, FL.
2. Siemens, Washington, DC
3. ABB, New Berlin WI.
4. Or approved Equal.

2.02 MATERIALS / EQUIPMENT

A. Electrical Requirements

1. The MV SPD operating voltage shall be 2.4 kV through 15 kV and configuration shall be as shown on the Drawings.
2. The Maximum Continuous Operating Voltage (MCOV) shall not be less than 115% of the nominal system operating voltage.
3. Impulse Withstand Voltage (BIL): 60 kV-200kV.
4. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels.
   a. Each thermally protected MOV shall have an end of life indicator and the suppression system shall be continuously self-monitoring.
   b. End of life mode to be open circuit.
   c. MV SPDs with end of life short-circuit mode are not acceptable.
   d. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
5. MV SPDs must not require external OCPD or replaceable internal OCPD for the UL Listing.
6. The MV SPD must protect all modes of the electrical system being utilized, i.e., Normal (L-L, L-N) and Common (N-G, L-G).
7. The Nominal Discharge Current (I_n) for all SPDS shall not be less 20 kA regardless of Type.

8. The MV SPD shall have proven “large block” 40mm round MOV technology.
9. MV SPD shall have less than 1 nanosecond response time.
10. MV SPD shall have low clamping voltage for maximum equipment protection.
11. MV SPD shall have bi-directional operation for positive and negative polarity surges.
12. Intended for High Energy applications including all IEEE C62.41.2.
13. MV SPD shall be solid state, automatic action and reset.
14. MV SPD shall parallel design MOV suppression allows installation flexibility.
15. MV SPD shall have double insulated against ground fault or arcing with redundant and separate polypropylene and polyethylene layers.

B. 15000 Volt solidly grounded distribution system ratings: 3 kV duty rated, 2.55 kV MCOV, maximum discharge voltage at 10kA (8 X 20 microsecond current wave) – 13 kV crest maximum.

C. Features

1. Balanced Suppression Platform
   a. Surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance.
   b. The surge suppression platform must provide equal impedance paths to each matched MOV.
   c. MV SPDs containing items such as single-mode replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted.
2. MV SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
3. Each thermally protected MOV shall have an end of life indicator and the suppression system shall be continuously self-monitoring.
4. MV SPDs with removable covers or doors shall be equipped with internal safety barriers having lockout provisions to prevent contact with energized components.
5. Internal Connections
   a. No plug-in single-mode modules or printed circuit boards shall be used as surge current conductors.
   b. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

6. Electrical Noise Filter

   a. Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter.

   b. Noise attenuation for electric line noise shall be 40 dB minimum from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable to meet this specification shall not be accepted.

   c. Type 2 units with filtering shall be co-listed to UL 1283 5th Edition or later.

   d. Type 1 units shall not contain filtering nor can they have a UL 1283 5th Edition Listing.

7. Monitoring and Diagnostics

   a. Protection Status Indicator

      1) Each MV SPD shall have a green/red solid-state indicator lights that reports the status of the protection on each phase.

         a) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes.

         b) Wye configured units shall also contain solid-state indicator lights that report the status of the protection elements and circuitry in the N-G mode.

         c) MV SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

         d) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

         e) The absence of a green light and the presence of a red/yellow light shall indicate that damage has occurred on the respective phase or mode.

         f) All protection status indicators must indicate the actual status of the protection on each phase or mode.

         g) If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes.

         h) Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor

1) MV SPDs, where shown on the Contract Drawings, must include Form C dry contacts (one NO and one NC) for remote annunciation of SPD status.

2) Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm

1) MV SPDs shall contain an audible alarm that will be activated under any fault condition.

2) There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter

1) MV SPDs shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location.

2) The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs.

3) A reset pushbutton shall also be standard, allowing the surge counter to be zeroed.

4) In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

5) If power to the MV SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored.

6) The surge counter's memory shall not require a backup battery in order to achieve this functionality.

8. MOV Protection

a. MV SPDs shall contain thermally protected MOVs.

b. The self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV.

c. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

d. Each thermally protected MOV shall have an end of life indicator and the suppression system shall be continuously self-monitoring.

9. Overcurrent Protection
   a. The unit shall not require external overcurrent protective device (OCPD) as part of the UL 1449 listing.
   b. If the AHJ requires overcurrent protection of the conductors connecting the MV SPD to the system then OCPD shall be sized based on governing AHJ electrical code requirements.

10. Fully Integrated Component Design
    a. All of the MV SPD's components and diagnostics shall be contained within one discrete assembly.
    b. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

11. Safety Requirements
    a. The MV SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable/replaceable parts and shall not require periodic maintenance.
    b. MV SPDs containing items such as replaceable single-mode plug in modules, replaceable fuses, or replaceable batteries shall not be accepted.
    c. MV SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device can pose a safety hazard and shall not be accepted.
    d. MV SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit or shall have barriers that block access to harmful voltages.
    e. Lockout provisions, capable of accepting a padlock, shall be provided on units with a disconnecting internal breaker if applicable.
    f. MV SPDs without barriers or lockout provisions shall be factory sealed to reduce exposure to harmful voltages.
    g. Factory sealed units shall have installed phase, neutral, ground and remote status contact conductors and shall have a pigtail set of conductors protruding outside of the enclosure for field installation.

12. The manufacturer shall certify that all materials and processes used as a component of the MV SPD units, and used in the process of manufacturing and packaging of the units are in accordance with The Federal Clean Air Act Amendments of 1990, Sections 602 and 611, prohibiting the use of Class I or Class II ozone depleting chemicals.

D. Medium Voltage Surge Arresters

1. The Medium Voltage Surge Arresters shall be designed for outdoor service conditions:

   a. Annual average ambient temperature: 30 ºC

   b. Maximum ambient temperature: 40 ºC

   c. Solar Radiation: 1.1 kW/m²

   d. Maximum Relative Humidity: 90%

   e. Environmental Condition: Humid tropical climate with polluted atmosphere

   f. Operational Altitude: Up to 1900 meters above Mean Sea Level

   g. Isokeraunic (Thunder day) level: 90 days

2. Medium Voltage Surge Arresters shall be connected between phase and earth to protect distribution transformers and switchgear. It shall complete the following:

   a. Clamps suitable to receive Copper/Aluminum (Line) Conductors from 4mm-16mm.

   b. Flexible Copper earth connection lead of 450 mm in length shall be provided with a Copper lug of hole diameter of 8 mm.

   c. The mounting clamps suitable for bracket mounting on a structure made of 100 X 50 X 6 mm Channel Iron.

3. The Medium Voltage Surge Arresters shall be of the non-linear metal oxide resister type without spark gaps and shall be housed in a hermetically sealed insulator casing to prevent ingress of moisture.

4. The housing insulator of the surge arrester shall be of polymeric type and the insulator sheds shall be designed to minimize trapping of contamination.

5. The manufacturing procedure shall include an effective leak test and the manufacturers shall carry out the Special Thermal Stability Test as specified in IEC 60099-4.

6. The Medium Voltage Surge Arresters sizing shall be in accordance with the requirements of Con Edison Specification E-2022.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. MV SPDs shall have NEMA 12 stainless steel enclosures suitable for locations indicated on the drawings and as described below:

1. NEMA 12

   a. Constructed of ANSI 61 painted steel.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the MV SPD at the manufacturer's plant prior to shipment.
2. Shop tests shall include the manufacturer's standard tests and shall demonstrate quality assurance inspection and testing procedures for the equipment.
3. The Contractor shall provide a shop test report to the Engineer for review and approval. The report shall identify the tests performed and the results obtained.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. MV SPDs of the appropriate listing shall be installed at locations shown on the Contract Drawings

B. Installation locations shall include Service Entrance Equipment, Distribution Equipment and Utilization Equipment.

C. MV SPD installations shall confirm to the manufacturer's written instructions and recognized installation practices including:

1. Proximity to the protected equipment
2. Strict adherence to the total length of conductors feeding the MV SPD.
3. Minimum bend radius of feed conductors.
4. Maximum number of bends in the feed conductors.
5. Whether the grounded conductor is to be bonded at the MV SPD.
6. Grounding of both the MV SPD and the protected equipment.

D. The MV SPD manufacturer shall make available experienced, qualified, power-quality application and field supervision engineering services during installation and start-up.

E. The Contractor shall verify the proper application of the MV SPDs (i.e. voltage, phase, etc.) and coordinate with upstream and downstream MV SPDs.

F. The Contractor shall assure that all neutral conductors are bonded to the system ground at the service entrance or at separately derived system point, prior to installation of the associated MV SPDs.

G. Install nameplates for identification of equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Manufacturer's Representative

B. A qualified representative from the MV SPD manufacturer shall assist in the installation of the MV SPDs, check the installation before it is placed into operation, observe and assist initial operations and train operations and maintenance staff in the care, operation and maintenance of the MV SPDs.

C. The service representative shall sign in with the Engineer on each day they are at the site.

D. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing individually mounted dry type transformers. Dry type transformers shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The following index of this Section is included for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 29 - Hangers and Supports for Electrical Systems

C. Section 26 05 53 - Identification for Electrical Systems

1.04 REFERENCES

A. Dry type transformers shall comply with the latest applicable provisions and recommendations of the following:

1.	NEC	-	National Electrical Code.
2.	NYCEC	-	New York City Electrical Code.
3.	UL 1561	-	Dry-Type General Purpose and Power Transformers.
4.	NEMA ST 20	-	Dry Type Transformers for General Application.
5.	NIST	-	US National Institute of Standards and Technology.
6.	ASTM D178	-	Electrical Switchboard Matting.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. General:

1. All transformers shall conform to the applicable NEMA, ANSI and IEEE Standards and shall be built by one approved manufacturer who shall use only best commercial materials and processes of manufacture.

2. Transformer enclosures shall have ample room for primary and secondary wiring connections.

3. All transformers shall be UL listed and certified to ANSI/NEMA sound levels.

4. The transformer manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration of testing apparatus shall be within one year of date of testing.

5. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology. Calibration of testing apparatus shall be within one year of date of testing.

B. Seismic Requirements

1. The transformer mounting system shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the NYS Building Codes.

2. Transverse and longitudinal bracing shall be provided as required to brace the transformer for the seismic requirements specified.

C. Field testing of the transformers shall be performed in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's catalog cuts for the transformers proposed for use.
2. Dimensional drawings showing transformer details with diagrammatic nameplate.
3. Transformer anchorage and mounting details prepared and stamped by a licensed engineer.
4. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least sixty (60) days in advance prior to conformation of witness testing dates and actual testing.

B. Shop test and field test reports shall be submitted.

C. Bill of Materials

D. Operations and Maintenance Manuals shall be submitted in accordance with the Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Dry type transformers shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Dry type transformers shall be as manufactured by:

1. General Electric Company, Stamford, CT.
2. Square D/Schneider Electric
3. ABB
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General Purpose Transformers

1. General purpose transformers shall be of the dry, commercially quiet, low temperature rise type consisting of two windings per phase.

2. Transformers shall have kVA rating, primary voltage and connection, secondary voltage and connection and number of phases as shown on the Contract Drawings.

3. Conductors for transformer windings shall be copper only.

4. Transformers shall be suitable for indoor or outdoor installation in accordance with the locations shown on the Contract Drawings.

5. Transformer insulation shall be rated 220 degrees C, 80 degrees C rise.

6. Transformers shall be equipped with six 2-1/2 percent fully rated taps, two above and four below the rated voltage tap on the primary winding.

7. The arrangement, assembly, and laminations of the core shall be such as to facilitate repair to the windings.

8. The design, shape, and arrangement of windings shall allow free flow of air for insulation and cooling.

B. Shielded Isolation Transformers

1. Shielded isolation transformers shall conform to the requirements specified under this Section for General Purpose Transformers and the following:

a. Shielded isolation transformers shall also include an electrostatic shield, grounded to the transformer case, to attenuate electrical noise.

C. Non-Linear Load Transformers

1. Non-linear load transformers shall conform to the requirements specified under this Section for General Purpose Transformers and the following:

a. Non-linear load transformers shall be specifically designed for non-sinusoidal loads.

b. Transformers shall be K-factor rated as shown on the Contract Drawings.

c. Transformers shall be provided with oversize neutral suitable to handle at least two-hundred (200) percent of normal phase current.

D. Insulating Floor Mat

1. The Contractor shall furnish and install non-conductive floor mat in front of the Low-Voltage Distribution Transformer to provide insulation for the workers.

2. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Shop Tests

1. Shop tests shall be performed at the transformer's manufacturer's plant prior to shipment.

2. Shop tests shall demonstrate that the equipment tested conforms to the requirements specified.

3. Each transformer shall be given a routine test in accordance with the latest requirements of UL, ANSI and NEMA standards.

4. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

5. Transformer shop tests shall be performed consisting of the following:

a. Applied potential shall be performed.

b. Induced potential shall be performed.

c. No load losses shall be performed.

d. Voltage ratio shall be performed.

e. Polarity shall be performed.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Transformers shall be installed on walls or floors. Floor mounted transformers shall be installed on one (1) inch of Korfund sound absorber material on raised concrete base at locations shown on the Contract Drawings.

B. Sufficient access and working space shall be provided for ready and safe operation and maintenance.

C. Transformers mounting, supports and restraints shall confirm to the requirements of this Section and Section 26 05 29 – Hangers and Supports for Electrical Equipment.

D. Transformers shall be grounded in accordance with the requirements of Section 26 05 27 – Grounding and as shown on the Contract Drawings.

E. The transformer leads shall be provided with solderless, clamp type cable connectors.

F. Conduit runs shall be arranged for easy removal of the transformers.

G. Transformer nameplates shall be installed for identification of equipment. Nameplates shall be provided in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems.

3.03 FIELD TESTING / QUALITY CONTROL

A. Insulation resistance tests shall be performed on the transformers after installation.

B. The tests shall be witnessed by the Engineer and certified by the Contractor. The tests shall be performed by the Contractor who shall furnish all testing equipment.

C. The Contractor shall provide a field test report. The report shall identify the tests performed and the results obtained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Low-voltage switchgear. Low-voltage switchgear shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems

C. Section 26 05 53 - Identification for Electrical Systems

D. Section 26 05 73 - Power System Studies

E. Section 26 05 75 - Shock Hazard and Arc Flash Studies

F. Section 26 06 11 - Cable and Conduit Schedule

G. Section 26 11 16 - Secondary Unit Substations

H. Section 26 23 24 – Low-Voltage Generator Switchgear

I. Section 26 43 13 - Low-Voltage Surge Protective Devices

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 VAC and within the 600 V Class.

B. Reference Standards

1.	IEEE C37.13	-	Low-Voltage AC Power Circuit Breakers Used in Enclosures.
2.	IEEE C37.16	-	Preferred Ratings. Related Requirements, and Application Recommendations for Low-Voltage AC and DC Power Circuit Breakers.
3.	IEEE C37.20.1	-	Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
4.	IEEE C37.5	-	Instrument Transformers
5.	NFPA 70	-	National Electrical Code
6.	NYCEC	-	New York City Electrical Code.
7.	NEMA SG3	-	Low-Voltage Power Circuit Breakers.
8.	NEMA SG-5	-	Power Switchgear Assemblies.
9.	NEMA TR1	-	Transformers, Regulators and Reactors.
10.	NETA ATS	-	Acceptance Testing Specifications.
11.	US NIST	-	National Institute of Standards and Technology.
12.	UL 1066	-	Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
13.	UL 1449	-	Surge Protective Devices

14. UL 1558 - Metal-Enclosed Low-Voltage Circuit Switchgear.

1.05 DESCRIPTION

A. The circuit breaker ratings, quantities, function, and arrangement of the switchgear shall be as shown on the Contract Drawings.

B. The low-voltage switchgear ratings shall be in accordance with Table 1 below:

Table 1-Switchgear Ratings

Parameter	Value
Nominal Voltage	480 VAC
Voltage Class	600 VAC
Main Bus Ampacity	4000A
Main Bus Short Circuit Rating	100 kAIC
Phase	3
Frequency	60
No of Wires	3
Neutral Bus Size	None
Ground Bus Size	0.25 x 4”
Enclosure NEMA Rating	NEMA 12

1.06 QUALITY ASSURANCE

A. Low-voltage switchgear shall be designed, built, and tested in accordance with the requirements of IEEE, NEMA, UL, the Utility, the NEC and local codes.

B. The low-voltage switchgear manufacturer shall be the manufacturer of all the major components of the switchgear as specified in this Section, the Specifications and as shown on the Contract Drawings.

C. All low-voltage switchgear equipment shall be new within six (6) months of manufacture and complying with the requirements of this Section, the Specifications, and the Contract Drawings.

D. The manufacturer of the low-voltage switchgear shall have produced switchgears for a minimum period of the last continuous fifteen (15) years.

E. The low-voltage switchgear manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

1. The Quality Assurance Program shall be the manufacturer’s standard program specifically dedicated to ensure that each switchgear and its components are designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings.

F. All cable and wire terminations at the switchgear equipment terminations shall be done by experienced installers who have worked with similar switchgear for a

period of at least five (5) years, using materials and procedures recommended by the switchgear manufacturer.

G. The Contractor shall retain the services of the switchgear manufacturer's representative to certify that the switchgear installation is in accordance with the manufacturer's requirements.

H. Seismic Requirements

1. The Contractor shall provide low-voltage switchgear designed, constructed, and installed suitable for earthquake regulations in accordance with the requirements of Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems and the NYS Building Codes, and local code requirements.

I. Testing

1. The switchgear manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all Shop and Field Tests.

2. Calibration of testing apparatus shall be within one year.

3. Shop testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.

4. Field testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.

5. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. NIST and NETA ATS.

J. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for approval by the Engineer.

B. Submittals shall include, but not be limited to:

1. Certified copy of the manufacturer's Design Tests made in accordance with all applicable UL, ANSI, IEEE Standards and conducted on switchgear models and type that is being offered for this contract.
2. Certified dimensioned outline drawings showing equipment layouts, front and side views, and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.
4. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as, ducts, cables, conduit, etc.
5. Weight of the switchgear and all associated equipment and distribution on the foundation support of the static, impact, and other loads.
6. Erection drawings and procedures.
7. Single-line diagrams
8. Detailed Elementary, Schematic, Wiring and Interconnecting Diagrams showing the arrangement, size and location of all electrical interface point having their terminals identified and indicating the internal wiring and all control and test switch developments of each compartment.
    a. There should clear indications as to what wiring, components are manufacturer supplied and what are not.
9. Common Elementary and Interconnection Wiring Diagrams are not acceptable.
10. Wire lists in lieu of wiring diagrams are not acceptable.
11. Separate customized drawings for each switchgear shall be supplied including individual point-to-point wiring diagram.
12. Complete three and two-line diagrams detailing connections for protective devices, switches, relays, meters, etc.
13. Complete Bill of Material.
14. Details of special features.
15. Instruction manuals of all protective relays for the equipment.
16. Nameplate schedules.
17. Recommended spare parts list with pricing.
18. List of Special Tools.

19. Painting Procedures.
20. List of recommended lubricants.
21. Testing Submittals
    a. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted.
    b. Testing methods and procedures shall be submitted at least 90 days in advance prior to conformation of witness testing dates and actual testing.
    c. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least ninety (90) days in advance of actual testing. Five recent references with phone numbers shall be submitted.
22. Seismic Criteria
    a. Calculations demonstrating compliance with Section 26 05 48 - Vibration and Seismic Controls for Electrical Equipment and NYS Building Codes.
    b. Switchgear anchorage details with design calculations signed and sealed by NYS Licensed Engineer.
23. Operation and Maintenance Manuals
    a. Preliminary Operation and Maintenance manuals.
    b. Finalized Operation and Maintenance manuals.
24. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the switchgear satisfies the requirements stated in this Section.
    b. Seismic qualification certification from the manufacturer including mounting recommendations.
    c. Data and results of witness tests shall be accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.
25. Reports.
    a. All certified and witnessed shop test reports.
    b. Field test reports.
    c. All manufacturer's Site visit reports.
26. Mimic Diagrams
    a. Mimic Diagrams submittals shall be a two-step process.

1) An initial submission describing the proposed graphic submission fully including the colors, line sizes, and all features. This submittal will be subject to change and approval.

2) A second on final submission incorporating all approved elements of the first submission. The final submission shall accompany all initial and revised switchgear submittals.

C. The Contractor is responsible to make submissions of all applicable drawings, specifications, and studies to Authorities Having Jurisdiction (AHJs) and Utilities for approvals and review.

1. Where submissions are required to be made by a Professional Engineer the Contractor shall secure these services at no additional cost to the City.

2. These submissions for approvals and review include those required by the NEC, local codes and administered by the local government, New York State Building Codes and those of the Utility.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Low-voltage switchgear equipment shall be delivered, stored, protected, and handled in accordance with this Section, the Specifications, the manufacturer's instructions and the following:

1. Switchgears shall be inspected when received, for shipping damage, water intrusion which may have entered the equipment during transit or loose parts and a report of any damage made to the carrier within the specified time.

2. Switchgears shall be shipped and delivered in convenient shipping splits, each split not to exceed lengths as recommended by the manufacturer.

3. Each split shall be mounted on shipping skids and wrapped for protection.

4. Bus bars along with associated hardware for connections between shipping groups/splits shall be shipped inside the splits in which it shall be installed.

5. Shipping splits shall contain accessories to permit handling by cranes.

6. Switchgear equipment shall be stored indoors in a clean, dry, and cool location in which a uniform temperature is maintained.

7. Switchgear equipment shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.

8. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

9. Embedded electronics shall be shielded from harmful electrical and magnetic energy fields.

10. Switchgear equipment shall be lifted, rolled, or jacked into locations shown on the Contract Drawings.

11. Switchgear shall be handled and placed in final positions without all withdrawable circuit breakers.

12. Where cranes are not available, it shall be possible for splits to be skidded into final positions on rollers and using jacks to raise and lower.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts, special tools and supplies for the switchgear in accordance with this Section and the Specifications.

B. The Contractor shall furnish all spare parts, special tools and supplies as recommended by the switchgear manufacturer.

C. The spare parts, special tools, and supplies shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

D. Furnish in addition the following spare parts for each switchgear:

1. Spare feeder breakers shall be provided in the quantities and sizes as required, and indicated on the Contract Drawings.

2. One (1) set of power fuses shall be provided of each size and type used.

3. Two (2) sets of control power fuses shall be provided of each type and size used.

4. Two (2) per ten pilot lights shall be provided of each type used.

5. One (1) spare key shall be provided for each key interlock system.

E. Furnish the following protective equipment and tools:

1. One (1) set each of protective equipment and tools for each switchgear.

2. Personnel protective equipment shall confirm to the requirements of the BWS E&HS.

3. Personnel protective equipment required to satisfy the requirements of Section 26 05 75 – Shock and Arc Flash Studies shall at the minimum consist of:

a. Safety Goggles

b. Face shields

c. Protective Apron

d. Protective Overshoes

e. Carrying case for the above equipment

4. Three 25 ft. ground cable sets for use with the ball studs specified in this Section.

F. Furnish the following special tools for each switchgear:

1. Breaker lifting yoke device.

a. Breaker lifting device shall be capable of inserting and removing any breaker from the disconnect position of any compartment and lowering it to ground level or onto a breaker moving device. Switchgear mounted lifter shall be furnished.

2. Breaker moving device.

a. Breaker moving device/"Dockable" transport dolly shall be capable of moving any breaker into and out of any compartment and around the switchgear room.

3. One (1) infrared thermometer per site suitable for viewing and recording temperatures and temperature spectra through the viewing windows specified in this Section.

4. Remote Racking Device with remote control pendant.

G. Furnish the following supplies for each switchgear:

a. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the switchgear equipment furnished under this section for a period of one (1) year after substantial completion.

1) Replace all lubricants used during start-up and testing prior to acceptance of equipment.

2) Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchgear equipment shall be as manufactured by:

1. Schneider Electric, Columbia, SC;

2. ABB, Burlington, IA;

3. Or approved equal.

B. Key interlock systems shall be as manufactured by:

1. Kirk, Canton OH;
2. Or approved equal.

C. Ball grounding studs and covers shall be as manufactured by:
1. AB Chance, Centralla, MO;
2. Or approved equal.

D. Ground cable set for use with ball studs shall be as manufactured by:
1. AB Chance, Centralla, MO;
2. Or approved equal.

E. Infrared thermometers shall be as manufactured by
1. Fluke Phoenix, AR;
2. Or approved equal.

F. Infrared monitoring windows shall be as manufactured by
1. Fluke Phoenix, AR;
2. Or approved equal.

G. Programmable Logic Controllers (PLC) shall be manufactured by
1. Schneider Electric, Andover, MA;
2. Allen Bradley, Milwaukee, WI;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Each switchgear shall be arranged in vertical sections.

B. The arrangement of each switchgear section shall be as shown on the Contract Drawings.

C. Each switchgear vertical section shall be separated from the others by steel barriers but electrically connected and physically joined to form a single, metal-enclosed structure arranged to form a continuous lineup.

D. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated, and finished with ANSI No. 61 indoor light grey paint.

E. Enclosure and Structure
1. The low-voltage switchgear shall be of a self-contained, totally enclosed, rigid, dead-front and self-supported structure having individual power circuit breaker or instrument compartments, transition compartments, a centralized bus compartment, and rear cabling compartments. The switchgear structure shall be in accordance with the following:

a. The rear cable compartment shall be segregated from the bus compartments by means of solid insulating barriers. Rear compartments shall be equipped with hinged access doors.

b. Each individual breaker compartment shall be completely segregated from adjacent compartments by means of barriers at rear, top, bottom and sides. It shall be equipped with draw out rails, levering out mechanism, and primary and secondary contacts.

c. Current transformers required for metering and protection, where shown on the drawings, shall be located within the appropriate breaker compartment and be front accessible.

d. The feeder circuit breakers shall be arranged for termination of steel conduit and copper cable feeders. Crimp type terminals, suitable for the cables furnished shall be provided for all cable terminations. The number of conduits and cables associated with each feeder shall be in accordance with the Section 26 06 11 - Cable and Conduit Schedule.

e. Electrical or key interlock systems shall be provided to enable predetermined sequences of breaker operation and movement. The interlock systems shall be complete with all necessary keys and locks required for the sequences shown.

F. Buses

1. The low-voltage switchgear power bus shall be three phase, tin-plated copper. The bus system shall be in accordance with the following:

a. The main and vertical buses shall be phase and ground isolated and insulated from each other.

b. Bus sizing and insulation shall be in accordance with the NEC.

c. Bus joints shall be provided with Belleville-type washers.

d. Provisions shall be made on the end compartments of the switchgear to allow for future bus extensions.

e. Each circuit shall consist of the necessary bus connection between the section bus and the breaker line side stabs. Load stabs shall be equipped with load extension buses terminating in bolted type terminals in the rear cable compartment.

f. A tin-plated copper ground bus shall extend the entire length of the switchgear and be available and firmly affixed to each vertical section.

g. The ground bus short-time withstand rating shall exceed that of the largest breaker in the switchgear.

h. The ground bus shall be drilled with lugs of appropriate capacity.

i. Reuseable insulating boots shall be provided to cover all power cable terminations.

3. Aluminum bus bars are not acceptable.

G. Breakers

1. The switchgear shall include low-voltage power circuit breakers, 3 pole, draw out type and shall include an electronic microprocessor-based trip system. Breaker frame size and sensor rating shall be as indicated on the Contract Drawings. Switchgear breakers shall be in accordance with the following:

a. Each circuit breaker shall be UL listed for 100 percent continuous ampere rating when operating within the switchgear compartment.

b. Each circuit breaker shall be an electrically operated stored energy mechanism with provisions for local and remote operation and capable of local manual powered and unpowered operation. Electrically operated breakers shall be complete with AC or DC operators, open/close push buttons and control switches as shown on the Contract Drawings.

c. The Open/Close push buttons shall be covered by pad-lockable plastic hinged cover.

d. Each circuit breaker shall be equipped with Truck-Operated switches (TOC) and properly wired for interlocking purposes. Each circuit breaker shall not be operated from the front of the circuit breaker when it is connected/energized (racked-in position). It shall only be operated from remote control panel.

e. The breaker removable elements shall be equipped with the disconnecting contacts, wheels, and interlocks for draw out operation.

f. The draw out design shall permit closure of the compartment door with the breaker in the “connected”, “test” and “disconnected” positions. A mechanical interlock shall prevent breaker racking while in the closed position.

g. Provisions for padlocking shall be made for all positions.

h. The electronic trip system shall include a plug-in trip unit, a flux shift trip device and current sensor package. The trip unit, sensor and flux-shifting trip device shall be constructed as integral elements of the breaker, requiring no externally mounted assemblies for proper operation. Interchangeable current sensors and their associated rating plugs shall establish the continuous trip rating of each breaker.

i. The protection trip unit shall be solid state, microprocessor based, nine function type, and shall provide true RMS current sensing.

j. The trip units shall be equipped with electronic monitoring and communication circuitry in accordance with the following:

1) The trip unit's protective functions shall include adjustable continuous and instantaneous current elements with adjustable long time, short time, and zero sequence ground fault pickup and delay.

2) For each of the main and tie circuit breakers, it shall be possible to isolate the functioning of the instantaneous functions and the trip unit shall include a discriminator circuit to prevent the breaker from being closed and latched into a fault. The discriminator circuit shall have the capability of being disabled from the front of the unit.

3) The trip unit shall also include provisions for zone selective interlocking and means to modify trip unit response times during work on the switchgear.

4) The trip unit's monitoring and communication circuitry shall include communications, control, and energy monitoring features, to permit both local and remote interface with the breakers circuits from a breaker interface module at the switchgear or a networked human machine interface or workstation (HMI) at a central monitoring point.

5) The protective, monitoring and communication type trip units shall provide complete communications and energy monitoring functions and be capable of passing the following minimum information to the breaker interface module or the HMI.

a) Harmonic content and percent THD.

b) Wave form analysis.

c) Energy consumption plus VA and VAR.

2. Circuit breaker accessories shall include the following:

a. Closing handle shall be provided for maintenance.

b. Indicating lights shall be provided for circuit breaker status - red for "CLOSE", amber for "TRIP" and green for "OPEN."

c. Auxiliary contacts shall be provided for remote indication of circuit breaker status-open, close, racked in and, racked out.

d. Indicators shall be provided for overload, short circuit, and ground trip indication.

e. Hand-held programming device shall be provided for accessing, displaying, configuring, and testing each breaker trip unit.

H. Secondary Wiring

1. All secondary wiring (control, instrumentation, potential transformer, and current transformer) shall be provided and routed in the respective switchgear compartment, be front accessible and shall be in accordance with the Contract Drawings and the following:

a. Secondary wiring shall be SIS insulated, extra flexible copper wire, bundled and secured with nylon ties and routed within ventilated wire troughs or routed on insulated standoffs.

b. Secondary wiring shall be No.16 AWG minimum for instrumentation circuits, No. 14 AWG minimum for control, No.12 AWG for potential transformer circuits and No.10 AWG for current transformer and shunt trip circuits.

c. All secondary wiring shall be marked at both ends with permanent labels to show the origin and destination.

d. All current transformer secondary leads shall first terminate at accessible shorting terminal blocks before connection to any device. Shorting screws with provision for storage shall be provided.

e. All secondary wiring shall terminate in terminal blocks where all field connections shall be made.

f. All device terminals shall be terminated at terminal blocks.

g. All field connections shall be made on one side of the terminal block and the side shall correspond to all terminal blocks.

h. Terminal blocks shall be provided with suitable numbering strips and terminations shall be grouped as to function.

i. All control wires intended for connection to remote panels shall be factory wired internally from each breaker to a common terminal block in each compartment. Connections shall then be made from compartment terminal blocks to marshalling terminal blocks in each half of the switchgear such as I/O compartments or sections.

I. Accessories

1. Control Power Sources

a. The switchgear shall include a 120-volt AC source suitable for operation as required of circuit breakers, meters, and status lights.

b. The 120-volt source shall be distributed from UPS backed panelboard to the switchgear devices.

2. Pull Fuses

a. The switchgear shall be equipped with pull fuse disconnects for the power sources.

b. The pull fuse disconnects shall be of the current interrupt disconnect block type with a fuse holder section in the removable pull out head.

c. The rating of the pull fuse disconnects shall be as shown on the Contract Drawings.

3. Surge Protective devices (SPD)

a. Each Bus of the Switchgear shall be equipped with an integral SPD. SPDs shall:

1) Comply with Section 26 43 13 – Low-Voltage Surge Protective Devices.

2) Be fed by its own circuit breaker or disconnect.

3) Have a minimum short circuit withstand rating of 3000 amps per phase.

4) Be capable of displaying its status without accessing the interior of the switchgear.

4. Metering

a. The switchgear shall include bus or feeder metering.

b. The bus metering shall consist of three (3) current transformers, ampere ratio as shown on the Contract Drawings, and a microprocessor-based meter device.

c. The meter device shall include self-contained potential transformers and internal fuses, and shall include the following direct reading metered values:

1) AC Current, each phase.

2) AC Voltage phase to phase and phase to neutral.

3) Power each phase and totalized value for all phases.

4) Reactive Power each phase and totalized value for all phases.

5) Total VA. each phase and totalized value for all phases.

6) Power factor each phase and totalized value for all phases.

7) Power, Reactive power, and Total VA demands each phase and totalized value for all phases.

8) Voltage and Current Harmonic up to the 50th harmonic.

9) Frequency with an accuracy of plus or minus 0.5%.

10) Percent THD and TDD.

d. Unit shall have the capability to communicate all measured and computed values to remote points on or off the switchgear.

5. Breaker Status and Parameter Monitors

a. The switchgear shall include an electronic interface module.

b. The module shall permit central monitoring and display of each circuit breaker trip unit parameters.

c. The module shall also communicate information from the protective and energy monitoring type trip units over a remote monitoring network or local monitoring and setting device.

d. The module shall permit configuration, display and testing features and shall include the following displayed parameters.

1) Phase and average demand current.

2) Present and peak demand watts.

3) Energy.

4) Trip information.

5) Percent THD.

6) Percent harmonic content.

6. Remote Electronic Communication

a. The switchgear shall contain all the equipment necessary to permit all values generated by metering devices and breaker status and parameter monitors to be transmitted to local devices on the switchgear or remotely.

b. All remote transmitting devices shall have the relevant interfaces to interconnect the switchgear devices communication protocols with site communication protocols.

7. Safety Grounding Provisions

a. For maintenance grounding provisions, ball studs shall be installed on the buses in accessible locations near access doors and shall be spaced on 6” centers.

b. Two ball studs shall be installed in each location specified. The same number of studs shall be installed on both the ground bus and each phase bus.

c. Ball studs shall be minimum ASTM F 855 Grade 5, tin plated bronze alloy with a 1-inch ball, rated 43,000 amps for 15 cycles and 30,000 amps for 30 cycles.

d. Ball studs shall be furnished with removable covers and sufficiently spaced to meet uninsulated clearance for 600VAC Class.

e. Ball stud locations shall be:

1) On the stationary ground bus in the circuit breaker compartments.

2) On the stationary ground bus in the cable compartments.

3) On the feeder cable termination bus in the cable compartments.

8. Infra-red Inspection Windows

a. The rear doors of each switchgear section with power cable termination or bus connections shall be equipped with an infrared inspection system for thermo-graphic inspection of the power cable terminations or bus connections with the door closed.

b. The system shall be positioned such that all the power cable terminations or bus connections are visible through the lens.

c. The system shall consist of an infrared lens of 2-inch (50-millimeter) diameter minimum and mounting hardware.

9. Nameplates

a. Nameplates shall clearly indicate information in accordance with NEMA and IEEE requirements.

b. Nameplates shall be engraved or embossed on stainless steel.

c. The switchgear shall have identifying nameplates in accordance with the requirements of Section 26 05 53 - Identification for Electrical Systems.

d. Nameplates shall clearly indicate information in accordance with NEMA and IEEE requirements.

e. A master nameplate shall also be provided mounted on the assembly.

f. The master nameplate shall identify switchgear designation, voltage, ampere and short circuit rating, manufacturer's name, general order number and item number.

10. Mimic Diagram

a. As shown on the Contract Drawings, a Mimic Diagram representing the single line diagram of the switchgear shall be painted or affixed to the front elevation of mimic panel.

b. The diagram shall begin with the incoming feeders, incorporate graphic representations of all the main elements of the switchgear that are fed or within the switchgear, such as transformers and breakers, and terminate in graphic or labeled representations of loads fed by the switchgear.

11. Arc Flash Mitigation

a. The Switchgear and shall be equipped with energy-reducing arc flash mitigation system. The Switchgear shall have Arcflash Reduction Maintenance System with integral selector switch with (5) five arc-flash reduction settings. The Contractor shall provide Switchgear arc energy reduction system documentation to the Engineer.

12. LV Switchgear Mimic (Remote Control) Panel/Annunciator with PLC Based Auto Transfer Control

a. A stand alone LV Switchgear Mimic (Remote Control) Panel shall be provided as shown the Contract Drawings.

b. It shall be possible to execute from the Mimic Panel all the operations an operator can accomplish while standing directly in front of the switchgear such as opening and closing breakers and verification by status indicators.

c. The Mimic Panel shall have a Mimic Diagram as described in this Section, except that all graphic representations of circuit breakers shall be replaced by actual breaker control switches one for each breaker, along with corresponding breaker and device status indicators.

d. All indicator lamps shall be low burden LED type with power taken from the same source as the switchgear.

e. All breaker control switches shall be of the same make and model as used on the switchgear.

f. The Mimic Panel shall be fabricated in UL listed panel shop.

g. The panel shall be NEMA Type 12.

h. The panel shall be an enclosed, front accessible and fabricated from reinforced sheet steel.

i. The system shall function in accordance with the control devices shown on the Contract Drawings and required for proper operation. The system control shall be customized in order to operate in conjunction with the LV switchgear, generator(s) and the generator switchgear.

j. Redundant PLCs shall be provided and configured in hot standby arrangements.

k. The system shall be able to be tested by operating the test switches on HMI. It shall be a live test, and the system shall respond as if a real failure had occurred. Test function shall self- cancel, if a real failure shall take place while testing.

l. All user-settable time delays shall be set using the setting page on HMI. Delay time could be changed by designated operators at any time.

m. The Mimic Panel PLC sequencing controller shall sequence the various switchgear breakers during automatic operation in accordance with the operational description specified in this Section.

n. The mimic panel shall include an automatic open transition, transfer control scheme. The procedures of the control scheme operations shall be as described below in this Section.

o. The control system shall permit automatic and manual starting, stopping of the generators and the utility supplies.

p. Emergency operation: if controls are inoperative or no control power is available, all breakers may be manually operated.

13. Interlock:

a. The Low-voltage switchgear shall be equipped with one key interlock systems. The interlock systems shall be complete with all necessary keys and locks required for operation of the following schemes:

1) The interlock shall cause the Low-voltage switchgear main breaker to be interlocked with the corresponding transformer primary disconnect device by keying, so that transformer disconnect device cannot be opened when the Low-voltage switchgear main breaker is closed.

b. Additional electrical interlocks shall be provided as shown on the Contract Drawings.

14. Insulating Floor Mat

a. The Contractor shall furnish and install non-conductive floor mat in front of the switchgear to provide insulation for the workers.

b. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

J. Automatic Transfer Control Scheme Logic:

1. The Mimic Panel shall have an Auto-Off-Manual selector switch.

a. Auto Mode: Auto transfer scheme shall perform the following:

1) The auto mode shall not be available unless the Automatic Transfer Scheme controller is running normally on its controller, all circuit breakers of GEN-1 (such as Generator Breaker, 52-LV-GM1, 52-LV-GA2, 52-LV-GA1), GEN-2, and 52-LV-MA/52-LV-MB are not locked off, all circuit breakers over temperature (tripped) have been reset.

2) If any of above mentioned breaker trips, all scheme automatic functions shall cease. The faulted breaker and over current trip must be reset in order to re-establish Auto Mode.

3) Both Utility Feeders Failed:

a) When the Auto Transfer Control (ATC) Scheme senses both utility feeders (52-LV-MA and 52-LV-MB) failed, the ATC shall send the start signal to both standby generator(s) and start the generator engines.

b) On the meantime, Main circuit breakers 52-LV-MA, and 52-LV-MB, and Tie circuits breakers (if closed) 52-LV-TIE-A, and 52-LV-TIE-B shall open. Also, feeder circuit breakers 52-LV-1A and 1B, 52-LV-2A and 2B, 52-LV-3A and 3B, 52-LV-4A and 4B, LV-52-6A and 6B, 52-LV-7A and 7B, and 52-LV-9A and 9B shall open.

c) After ATS scheme verified 52-LV-MA, 52-LV-MB, 52-LV-TIE-A, and 52-LV-TIE-B were in open position, then circuit breakers 52-LV-GA1 and 52-LV-GB1 shall close. At this point, the standby generators are feeding the Electrical Building and Screen Chamber Building loads, and the utility feeders are locked out.

d) After adjustable time pause, the ATC scheme shall close the feeder circuit breakers in the following

order with 5 seconds time delays (adjustable) in between closing circuit breakers of each facility:

(1) 52-LV-4A and 4B (Fluoride Building),

(2) 52-LV-7A and 7B (Police Booth),

(3) 52-LV-3A and 3B (LAB Building),

(4) 52-LV-6A and 6B (Waterfowl Building),

(5) 52-LV-1A and 1B (UEC Building),

(6) 52-LV-2A and 2B (LEC Building),

e) Operators shall have choice of manually turn off one of the running generators if it is determined the connected facilities running loads are less than 80% (adjustable) of one generator's full capacity.

f) Re-transfer back to utility feeders: When the scheme detects both utility feeders are back in service, operators shall manually re-transfer power supply from the standby generator(s) to utility services. Operators shall manually open 52-LV-GA1, then close 52-LV-MA, and close 52-LV-9A. Observe the utility feeder and make sure it is stable, then manually open 52-LV-GB1, then close 52-LV-MB, and close 52-LV-9B.

g) Observe and confirm that the utility feeders are normal and stable. Then, manually turn off the generator circuit breakers, GEN-1, and GEN-2.

4) One Utility Feeder Failed:

a) When ATC Scheme detects one of the utility feeders failed, the Mimic Panel shall display an alarm on the Mimic Panel/Annunciator and send an alarm signal to remote monitoring/control office.

b) ATC Scheme shall open and lockout the failed utility breaker (52-LV-MA or 52-LV-MB) at LV switchgear.

c) After ATS scheme verified failed utility breaker (52-LV-MA or 52-LV-MB) were in open position, then Tie circuit breaker 52-LV-TIE-B shall close.

d) Re-transfer back to utility feeders: When the scheme detects the failed utility feeder is back in service, operators shall manually re-transfer power supply. Operators shall manually open 52-LV-TIE-

B, then close the utility breaker 52-LV-MA, or 52-LV-MB.

b. Off Mode:

1) Auto transfer scheme shall be disabled.

c. Manual Mode:

1) Auto transfer scheme shall be disabled, but operators can start the generator(s) manually.

2) If one of the utility feeders failed, operators can manually open the associated (52-LV-MA or 52-LV-MB) breaker and close the Tie breaker.

2. The table below indicates all related circuit breakers final status (open/closed) during normal utility services, standby generators service, and re-transfer to utility feeders.

Breaker Tag	Utility (both feeders are normal)	Standby Generator(s) (both Utility failed, generator(s) running)	Re-Transfer (Open/Close manually by Operator)
52-LV-MA	Closed	Open	Closed
52-LV-MB	Closed	Open	Closed
52-GEN-1	Open	Closed	Open
52-GEN-2	Open	Closed (Manually Open as desired)	Open
52-LV-GA1	Open	Closed	Open
52-LV-GB1	Open	Closed	Open
52-LV-1A	Closed	Open/Closed*	Closed
52-LV-1B	Closed	Open/Closed*	Closed
52-LV-2A	Closed	Open/Closed*	Closed
52-LV-2B	Closed	Open/Closed*	Closed
52-LV-3A	Closed	Open/Closed*	Closed
52-LV-3B	Closed	Open/Closed*	Closed
52-LV-4A	Closed	Open/Closed*	Closed
52-LV-4B	Closed	Open/Closed*	Closed
52-LV-5A	Closed	Closed	Closed
52-LV-5B	Closed	Closed	Closed
52-LV-6A	Closed	Open/Closed*	Closed
52-LV-6B	Closed	Open/Closed*	Closed
52-LV-7A	Closed	Open/Closed*	Closed
52-LV-7B	Closed	Open/Closed*	Closed

52-LV-8A	Closed	Closed	Closed
52-LV-8B	Closed	Closed	Closed
52-LV-9A	Closed	Open	Closed
52-LV-9B	Closed	Open	Closed

* Upon loss of both Utility, the ATC scheme shall open the circuit breaker first and after adjustable time pause (generator sync and ready), the ATC scheme shall close the feeder circuit breakers in the order describe above with 5 seconds time delays (adjustable) in between closing circuit breakers of each facility.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. All metal surfaces of the switchgear/s shall be thoroughly cleaned and given one coat of zinc chromate primer.
2. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose lacquer enamel.
3. All exterior surfaces shall be given three coats of the same lacquer. The color of the exterior finishing coats shall be light gray ANSI No. 61.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Each switchgear shall be completely assembled, wired, and tested at the factory, including all buses, connections, insulator, terminals, and terminal blocks, to demonstrate that it has been properly manufactured, properly assembled, is not overheating, is not overloading and has no electrical or mechanical defects.
2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment.
3. Shop test shall be in accordance with the latest revisions of IEEE and ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.
4. The Contractor shall provide a Certified Shop Test Report.
    a. The report shall identify the tests performed and the results obtained.
5. Switchgear shop tests shall include the following:
    a. Visual and physical inspection of the interior and exterior of the switchgear including all devices to verify consistency with approved submittals.

1) Check bus layouts and takeoffs confirm with approved submittals.

2) Check bus for proper electrical clearances.

3) Check tightness of all bolted and torqued connections.

4) Verify the polarity of all instrument transformers.

5) Verify the grounding of all instrument transformers.

6) Verify all nameplate engravings.

b. Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.

c. Continuity test shall be performed on power and control wires.

d. Functional operations test which shall include pick up, dropout, time delay, sequence, and polarity.

e. Primary hi-potential tests shall be performed.

1) Primary current carrying parts shall be tested between phases, phase to ground, and line to load.

2) The applied voltage shall be twice rated voltage plus 1000 for one (1) minute.

f. Hi-Potential tests on control and secondary wiring shall be performed.

1) Control circuit wiring shall be tested for 1500 volts to ground for one (1) minute.

g. Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation.

1) Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

h. Verify connectivity and communication of devices to be connected to the Network Rack.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests.

3. For the Witnessed Shop Test the Contractor shall perform all the Certified Tests in the presence of the witnesses.

4. The Contractor shall submit a Witnessed Shop Test Report.

a. The report shall identify the tests performed, the results obtained, contain all raw data sheets, certified test data, calibration certificates, punch lists and confirmation as to how punch lists items were resolved.

5. Switchgear shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine installation area to assure there is enough clearance to install switchgear.

B. Verify that installation will yield required working spaces around the switchgear installation.

C. Furnish and check concrete pads for uniformity and level surface.

D. Verify field measurements are as shown on the approved Shop Drawings.

E. Verify that required utilities are available, conduit stubs etc. are in required location and ready for use.

3.02 INSTALLATION

A. Switchgear and associated equipment and accessories shall be installed in accordance with manufacturer's instructions and recommendations.

B. Switchgear shall be bolted to the concrete bases and shall comply with seismic requirements of Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems and the NYCBC.

C. Switchgear equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

D. Switchgear equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

E. Steel channels shall be provided for support of switchgear equipment.

F. Switchgear equipment shall be securely mounted to mounting surfaces with anchor bolts.

G. Identification

1. Identify field-installed conductors, interconnecting wiring, warning signs and components in accordance with Section 26 05 53 – Identification for Electrical Systems.

2. Label each switchgear compartment with nameplates complying with Section 26 05 33 – Identification for Electrical Systems.

3. Provide device nameplates complying with Section 26 05 33 – Identification for Electrical Systems.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Testing

1. After installation, the switchgear shall be field tested for operation and conformance.
2. Field testing shall conform to the requirements in this Section, Section 01 75 10 – Preliminary and Final Field Tests, NETA ATS, and the Manufacturer's recommendations.
3. Field tests shall be witnessed by the Engineer and certified by the Contractor.
4. The services of the switchgear manufacturer shall be retained for field testing.
5. Switchgear testing shall be supervised by the Manufacturer's representative, prior to energizing equipment.
6. Equipment shall not be energized without the permission of the Engineer.
7. Retain the service of an independent testing firm who shall perform field testing of the switchgear.
    a. The testing firm shall have experience in the inspection and testing of low-voltage switchgear equipment and shall be a member company of NETA.
    b. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

B. Preliminary Field Testing

1. Preliminary Field Test of the switchgear shall be in accordance with the recommendations of the manufacturer's representative, NETA ATS and shall consist at a minimum of the following:
2. Visual and physical inspections shall at a minimum verify the following:
    a. Verify all switchgear equipment are located according to approved submittals.
    b. Verify all nameplates, tags, and identification marks in accordance with approved submittal and preliminary As Builts Drawing.
    c. Physical, electrical, and mechanical condition shall be inspected.
    d. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

e. Ventilating air passageways shall be inspected for blockage.

f. Mechanical interlock systems shall be checked for proper operation.

g. Insulators shall be inspected for evidence of damage or contamination.

h. Device settings and adjustments shall be verified.

i. Breakers and vertical sections shall be checked to determine that they have been properly installed, lubricated, and connected.

j. Equipment shall be cleaned and lubricated as required.

3. Electrical testing shall at a minimum include:

a. Test continuity of all circuits

b. All connections shall be inspected for high resistance.

c. Electrical interlock systems shall be checked for proper operation.

d. Ground-resistance tests shall be performed.

e. Perform resistance measurements through bolted connections with a low-resistance measuring device.

f. Perform insulation-resistance measurements on each bus section, phase-to-phase, and phase-to-ground for one minute.

g. An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

h. Contact-resistance test shall be performed.

i. Control and metering wiring performance test shall be performed.

j. Primary and secondary voltage and current injections shall be performed to confirm phasing, polarities, transformation ratios.

k. Circuit breaker trip characteristics shall be determined by primary current injection.

l. Control equipment and connections shall be checked to determine that they are not defective.

C. Preliminary Loading Tests

1. The Contractor may substitute load banks of the type and power factor which are approved by the Engineer to complete Preliminary Load Tests if the actual loads are not ready for energization.

a. The full load rating of the load bank shall be comparable to that of the circuit loads under test.

2. Preliminary Loading Tests shall at the minimum include:
    a. Control voltages shall be applied and functional tests verifying the operations of all breakers, controls and displays.
    b. Primary voltage shall be applied to the complete primary bus via the switchgear main feeder breakers with tie breakers in the normal operating positions.
        1) The primary buses shall remain energized for one hour with no further operations.
            a) During this one hour period all voltage and potential transformer secondaries and circuits shall be checked for voltage magnitudes, phasing, phase sequence along with all associated metering displays.
        2) After one hour the tie breakers shall be closed facilitating the energization of the complete bus from either main feeder for [one hour].
            a) During this one hour period all voltage and potential transformer secondaries and circuits shall be checked for voltage magnitudes, phasing, phase sequence along with all associated metering displays.
        3) Each switchgear distribution feeder breaker shall be closed for one hour to energize its associated load/load bank/feeder.
            a) During this one hour period all metering circuits shall be checked for voltage, current, volt, amp, and var values, phasing, phase sequence along with all associated metering displays.
        4) All switchgear distribution feeder breakers shall be closed for one hour to simultaneously energize all loads fed by the switchgear.
            a) During this one hour period all metering displays shall be checked.

D. Infrared testing shall be performed once after initial energization of the switchgear and a second time after full load has been applied continuously for (24) hours.

E. Switchgear Final Field Test

1. Switchgear Final Field Test shall be considered complete when all the outgoing circuits shall have energized their various loads for the Final Field Test of the respective load.

F. Any deficiencies or issues which may arise during Preliminary Field Tests, Preliminary Loading Test or Switchgear Final Field Test shall be remedied by the Contractor at no additional cost to the City.

G. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the switchgear, check the switchgear installation before it is placed into operation and assist in the performance of Preliminary and Final Field Tests.

2. The Manufacturer's representative shall provide switchgear equipment Start-up services and Training of the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the switchgear in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

a. Minimum number of manufacturer's representative site visits per low-voltage switchgear:

Visit Type	Minimum Number of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation and Inspection	1	2	5
Field Tests	1	2	5
Acceptance Startup	1	2	5
Training	1	2	3

b. Additional trips or days that are required to achieve the proper installation, operation or training, such services shall be arranged for by the Contractor at no additional cost to the City.

c. The Engineer shall have the right to reallocate any unused time.

3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.

a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

b. The switchgear manufacturer's representative shall certify in writing to the Engineer that the switchgear equipment has been installed, setup and tested properly in accordance with Contract requirements and is operating at optimum conditions and capacity.

4. The manufacturer representative shall also make any necessary adjustments and instruct the Site personnel in its operation and maintenance.

5. The service representative shall sign in and out with the Engineer on each day they are at the site.

6. A day shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. Switchgear Startup

1. Switchgear Startup shall comply with the requirements of Section 01 79 05 – Startup and Training and shall be considered completed when all the loads on the switchgear completes their startup requirements.

B. Switchgear Training

1. The Contractor shall provide Training on the switchgear in compliance with Section 01 79 05 – Startup and Training.

2. The Contractor shall submit for approval by the Engineer, lesson plans identifying in detail, the training to be conducted.

3. The Contractor shall coordinate training services with the City and the Engineer.

4. The Contractor shall schedule training at least forty-five (45) days prior to delivery of training subject to the approval of the Engineer and the City.

5. The training shall consist of both classroom and field instruction.

6. The purpose of field instruction shall be to reinforce topics covered in the classroom and to identify the location of any control switches and other equipment required for operation; and to identify locations of any maintenance equipment.

7. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

8. The manufacturer's representative shall sign in and out at the office of the Resident representative on each day he is at the project.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Low-voltage generators paralleling switchgear. Paralleling switchgear shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The paralleling switchgear shall consist of a section for generator load bank connection as shown in the Contract Drawings.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems

C. Section 26 05 53 - Identification for Electrical Systems

D. Section 26 05 73 - Power System Studies

E. Section 26 05 75 - Shock Hazard and Arc Flash Studies

F. Section 26 06 11 - Cable and Conduit Schedule

G. Section 26 23 23 - Low Voltage Switchgear

H. Section 26 25 00 - LV Metal-Enclosed Busway

I. Section 26 31 13 - Engine Generators

J. Section 26 32 36 - Resistive Load Banks

K. Section 26 43 13 - Low-Voltage Surge Protective Devices

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 VAC and within the 600 V Class.

B. Reference Standards

1.	IEEE C37.13	-	Low-Voltage AC Power Circuit Breakers Used in Enclosures.
2.	IEEE C37.16	-	Preferred Ratings. Related Requirements, and Application Recommendations for Low-Voltage AC and DC Power Circuit Breakers.
3.	IEEE C37.20.1	-	Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
4.	IEEE C37.5	-	Instrument Transformers
5.	NEC	-	National Electrical Code
6.	NYCEC	-	New York City Electrical Code.
7.	NEMA SG3	-	Low-Voltage Power Circuit Breakers.

8.	NEMA SG-5	-	Power Switchgear Assemblies.
9.	NEMA TR1	-	Transformers, Regulators and Reactors.
10.	NETA ATS	-	Acceptance Testing Specifications.
11.	NIST	-	National Institute of Standards and Technology.
12.	UL 1066	-	Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
13.	UL 1449	-	Surge Protective Devices
14.	UL 1558	-	Metal-Enclosed Low-Voltage Circuit Switchgear.
15.	Con Edison Specification – EO-2022		

1.05 DESCRIPTION

A. The circuit breaker ratings, quantities, function, and arrangement of the switchgear shall be as shown on the Contract Drawings.

B. The low-voltage switchgear ratings shall be in accordance with Table 1 below:

Table 1-Switchgear Ratings

Parameter	Value
Nominal Voltage	480V
Voltage Class	600 VAC
Main Bus Ampacity	4000A
Main Bus Short Circuit Rating	100 kAIC
Phase	3
Frequency	60
No of Wires	3
Neutral Bus Size	None
Ground Bus Size	0.25” x 4”
Enclosure NEMA Rating	NEMA 12

1.06 QUALITY ASSURANCE

A. Low-voltage switchgear shall be designed, built, and tested in accordance with the requirements of IEEE, NEMA, UL, the Utility, NFPA, NEC, and local codes.

B. The low-voltage switchgear manufacturer shall be the manufacturer of all the major components of the switchgear as specified in this Section, the Specifications and as shown on the Contract Drawings.

C. All low-voltage switchgear equipment shall be new within 6 months of manufacture and complying with the requirements of this Section, the Specifications, and the Contract Drawings.

D. The manufacturer of the low-voltage switchgear shall have produced switchgears for a minimum period of the last continuous fifteen (15) years.

E. The low-voltage switchgear manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

1. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure that each switchgear and its components are designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings.

F. All Work regarding the switchgear equipment shall conform to the requirements of the Utility.

G. All cable and wire terminations at the switchgear equipment terminations shall be done by experienced installers who have worked with similar switchgear for a period of at least five (5) years, using materials and procedures recommended by the switchgear manufacturer.

H. The Contractor shall retain the services of the switchgear manufacturer's representative to certify that the switchgear installation is in accordance with the manufacturer's requirements.

I. Seismic Requirements

1. The Contractor shall provide low-voltage switchgear designed, constructed, and installed suitable for earthquake regulations in accordance with the requirements of Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems and the NYS Building Codes and local codes.

J. Testing

1. The switchgear manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all Shop and Field Tests.

2. Calibration of testing apparatus shall be within one (1) year.

3. Shop testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.

4. Field testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.

5. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. NIST and NETA ATS.

K. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

L. Low-Voltage Generator Switchgear shall meet the requirements of Con Edison Specification EO-2022.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for approval by the Engineer.

B. Submittals shall include, but not be limited to:

1. Certified copy of the manufacturer's Design Tests made in accordance with all applicable UL, ANSI, IEEE industry standards and conducted on switchgear models and type that is being offered for this contract.

2. Certified dimensioned outline drawings showing equipment layouts, front and side views, and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.

3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with Specification requirements, including design and physical arrangement.

4. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as, ducts, cables, conduit, etc.

5. Weight of the switchgear and all associated equipment and distribution on the foundation support of the static, impact, and other loads.

6. Erection drawings and procedures.

7. Single-line diagrams

8. Detailed Elementary, Schematic, Wiring and Interconnecting Diagrams showing the arrangement, size and location of all electrical interface point

having their terminals identified and indicating the internal wiring and all control and test switch developments of each compartment.

a. There should clear indications as to what wiring, components are manufacturer supplied and what are not.

9. Common Elementary and Interconnection Wiring Diagrams are not acceptable.
10. Wire lists in lieu of wiring diagrams are not acceptable.
11. Separate customized drawings for each switchgear shall be supplied including individual point-to-point wiring diagram.
12. Complete three and two-line diagrams detailing connections for protective devices, switches, relays, meters, etc.
13. Complete Bill of Materials.
14. Details of special features.
15. Instruction manuals of all protective relays for the equipment.
16. Nameplate schedules.
17. Recommended spare parts list with pricing.
18. List of Special Tools.
19. Painting Procedures.
20. List of recommended lubricants.
21. Testing Submittals
    a. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted.
    b. Testing methods and procedures shall be submitted at least 90 days in advance prior to conformation of witness testing dates and actual testing.
    c. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least ninety (90) days in advance of actual testing. Five recent references with phone numbers shall be submitted.
22. Seismic Criteria
    a. Calculations demonstrating compliance with Section 26 05 48 - Vibration and Seismic Controls for Electrical Equipment and NYS Building Codes and local code requirements.
    b. Switchgear anchorage details with design calculations signed and sealed by NYS Licensed Engineer.

23. Operation and Maintenance Manuals
    a. Preliminary Operation and Maintenance manuals.
    b. Finalized Operation and Maintenance manuals.
24. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the switchgear satisfies the requirements stated in this Section.
    b. Seismic qualification certification from the manufacturer including mounting recommendations.
    c. Cybersecurity Equipment Certification
    d. Data and results of witness tests shall be accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.
25. Reports.
    a. All certified and witnessed shop test reports.
    b. Field test reports.
    c. All manufacturer's Site visit reports.
26. Mimic Diagrams
    a. Mimic Diagrams submittals shall be a two-step process.
        1) An initial submission describing the proposed graphic submission fully including the colors, line sizes, and all features. This submittal will be subject to change and approval.
        2) A second on final submission incorporating all approved elements of the first submission. The final submission shall accompany all initial and revised switchgear submittals.

C. The Contractor is responsible to make submissions of all applicable drawings, specifications, and studies to Authorities Having Jurisdiction (AHJs) and Utilities for approvals and review.
    1. Where submissions are required to be made by a Professional Engineer the Contractor shall secure these services at no additional cost to the City.
    2. These submissions for approvals and review include those required by the NEC, local codes and administered by the local government, New York State Building Codes, and the Utility.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Low-voltage switchgear equipment shall be delivered, stored, protected, and handled in accordance with this Section, the Specifications, the manufacturer's instructions and the following:

1. Switchgears shall be inspected when received, for shipping damage, water intrusion which may have entered the equipment during transit or loose parts and a report of any damage made to the carrier within the specified time.
2. Switchgears shall be shipped and delivered in convenient shipping splits, each split not to exceed in length as recommended by the manufacturer.
3. Each split shall be mounted on shipping skids and wrapped for protection.
4. Bus bars along with associated hardware for connections between shipping groups/splits shall be shipped inside the splits in which it shall be installed.
5. Shipping splits shall contain accessories to permit handling by cranes.
6. Switchgear equipment shall be stored indoors in a clean, dry, and cool location in which a uniform temperature is maintained.
7. Switchgear equipment shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.
8. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.
9. Embedded electronics shall be shielded from harmful electrical and magnetic energy fields.
10. Switchgear equipment shall be lifted, rolled, or jacked into locations shown on the Contract Drawings.
11. Switchgear shall be handled and placed in final positions without all withdrawable circuit breakers.
12. Where cranes are not available, it shall be possible for splits to be skidded into final positions on rollers and using jacks to raise and lower.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts, special tools and supplies for the switchgear in accordance with this Section and the Specifications.

B. The Contractor shall furnish all spare parts, special tools and supplies as recommended by the switchgear manufacturer.

C. The spare parts, special tools, and supplies shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

D. Furnish the following supplies for each switchgear:

a. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the switchgear equipment furnished under this section for a period of one (1) year after substantial completion.

1) Replace all lubricants used during start-up and testing prior to acceptance of equipment.

2) Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

1. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchgear shall be as manufactured by:

1. ASCO Power Technologies
2. ABB, Burlington, IA
3. Siemens, Washington, DC
4. Or approved equal.

B. Key interlock systems shall be as manufactured by:

1. Kirk, Canton OH;
2. Or approved equal.

C. Ball grounding studs and covers shall be as manufactured by:

1. AB Chance, Centralia, MO;
2. Or approved equal.

D. Ground cable set for use with ball studs shall be as manufactured by:

1. AB Chance, Centralia, MO;
2. Or approved equal.

E. Infrared thermometers shall be as manufactured by

1. Fluke Phoenix, AR;

2. Or approved equal.

F. Infrared monitoring windows shall be as manufactured by

1. Fluke Phoenix, AR;

2. Or approved equal.

G. Synchronizer shall be as manufactured by

1. Woodward DSLC-2

2. Or approved equal.

H. Programmable Logic Controllers (PLCs) shall be manufactured by

1. Schneider Electric, Andover, MA;

2. Allen Bradley, Milwaukee, WI;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Each switchgear shall be arranged in vertical sections.

B. The arrangement of each switchgear section shall be as shown on the Contract Drawings.

C. Each switchgear vertical section shall be separated from the others by steel barriers but electrically connected and physically joined to form a single, metal-enclosed structure arranged to form a continuous lineup.

D. All structures shall be fabricated of code gauge steel. Steel surfaces shall be chemically cleaned, treated, and finished with ANSI No. 61 indoor light grey paint.

E. Enclosure and Structure

1. The low-voltage switchgear shall be of a self-contained, totally enclosed, rigid, dead-front and self-supported structure having individual power circuit breaker or instrument compartments, transition compartments, a centralized bus compartment, and rear cabling compartments. The switchgear structure shall be in accordance with the following:

a. The rear cable compartment shall be segregated from the bus compartments by means of solid insulating barriers. Rear compartments shall be equipped with hinged access doors.

b. Each individual breaker compartment shall be completely segregated from adjacent compartments by means of barriers at rear, top, bottom and sides. It shall be equipped with draw out rails, levering out mechanism, and primary and secondary contacts.

c. Current transformers required for metering and protection, where shown on the drawings, shall be located within the appropriate breaker compartment and be front accessible.

d. The feeder circuit breakers shall be arranged for termination of steel conduit and copper cable feeders. Crimp type terminals, suitable for the cables furnished shall be provided for all cable terminations. The number of conduits and cables associated with each feeder shall be in accordance with the Section 26 06 11 - Cable and Conduit Schedule.

e. The feeder circuit breaker shall be arranged for termination of copper busway. The size of busway system shall be as shown in the Contract Drawings.

f. Electrical or key interlock systems shall be provided to enable predetermined sequences of breaker operation and movement. The interlock systems shall be complete with all necessary keys and locks required for the sequences shown.

F. Buses

1. The low-voltage switchgear power bus shall be three phase, tin-plated copper. The bus system shall be in accordance with the following:

a. The main and vertical buses shall be phase and ground isolated and insulated from each other.

b. Bus sizing and insulation shall be in accordance with the New York City Electrical Code (NYCEC).

c. Bus joints shall be provided with Belleville-type washers.

d. Provisions shall be made on the end compartments of the switchgear to allow for future bus extensions.

e. Each circuit shall consist of the necessary bus connection between the section bus and the breaker line side stabs. Load stabs shall be equipped with load extension buses terminating in bolted type terminals in the rear cable compartment.

f. A tin-plated copper ground bus shall extend the entire length of the switchgear and be available and firmly affixed to each vertical section.

g. The ground bus short-time withstand rating shall exceed that of the largest breaker in the switchgear.

h. The ground bus shall be drilled with lugs of appropriate capacity.

i. Reuseable insulating boots shall be provided to cover all power cable terminations.

G. Breakers

1. The switchgear shall include low-voltage power circuit breakers, 3 pole, draw out type and shall include an electronic microprocessor-based trip system. Breaker frame size and sensor rating shall be as indicated on the Contract Drawings. Switchgear breakers shall be in accordance with the following:

   a. Each circuit breaker shall be UL listed for 100 percent continuous ampere rating when operating within the switchgear compartment.

   b. Each circuit breaker shall be an electrically operated stored energy mechanism with provisions for local and remote operation and capable of local manual powered and unpowered operation. Electrically operated breakers shall be complete with AC or DC operators, open/close push buttons and control switches as shown on the Contract Drawings.

   c. The push button shall be covered by pad-lockable plastic hinged cover.

   d. Each circuit breaker shall be equipped with Truck-Operated switches (TOC) and properly wired for interlocking purposes. Each circuit breaker shall not be operated from the front of the circuit breaker when it is connected/energized (racked-in position). It shall only be operated from LV switchgear mimic (remote control) panel.

   e. The breaker removable elements shall be equipped with the disconnecting contacts, wheels, and interlocks for draw out operation.

   f. The draw out design shall permit closure of the compartment door with the breaker in the “connected”, “test” and “disconnected” positions. A mechanical interlock shall prevent breaker racking while in the closed position.

   g. Provisions for padlocking shall be made for all positions.

   h. The electronic trip system shall include a plug-in trip unit, a flux shift trip device and current sensor package. The trip unit, sensor and flux-shifting trip device shall be constructed as integral elements of the breaker, requiring no externally mounted assemblies for proper operation. Interchangeable current sensors and their associated rating plugs shall establish the continuous trip rating of each breaker.

   i. The protection trip unit shall be solid state, microprocessor based, nine function type, and shall provide true RMS current sensing.

   j. The trip units shall be equipped with electronic monitoring and communication circuitry in accordance with the following:

      1) The trip unit’s protective functions shall include adjustable continuous and instantaneous current elements with

adjustable long time, short time, and zero sequence ground fault pickup and delay.

2) For each of the main and tie circuit breakers, it shall be possible to isolate the functioning of the instantaneous functions and the trip unit shall include a discriminator circuit to prevent the breaker from being closed and latched into a fault. The discriminator circuit shall have the capability of being disabled from the front of the unit.

3) The trip unit shall also include provisions for zone selective interlocking and means to modify trip unit response times during work on the switchgear.

4) The trip unit's monitoring and communication circuitry shall include communications, control, and energy monitoring features, to permit both local and remote interface with the breakers circuits from a breaker interface module at the switchgear or a networked human machine interface or workstation (HMI) at a central monitoring point.

5) The protective, monitoring and communication type trip units shall provide complete communications and energy monitoring functions and be capable of passing the following minimum information to the breaker interface module or the HMI.

a) Harmonic content and percent THD.

b) Wave form analysis.

c) Energy consumption plus VA and VAR.

2. Circuit breaker accessories shall include the following:

a. Closing handle shall be provided for maintenance.

b. Indicating lights shall be provided for circuit breaker status - red for "CLOSE", amber for "TRIP" and green for "OPEN."

c. Auxiliary contacts shall be provided for remote indication of circuit breaker status-open, close, racked in and, racked out.

d. Indicators shall be provided for overload, short circuit, and ground trip indication.

e. Hand-held programming device shall be provided for accessing, displaying, configuring, and testing each breaker trip unit.

H. Secondary Wiring

1. All secondary wiring (control, instrumentation, potential transformer, and current transformer) shall be provided and routed in the respective switchgear compartment, be front accessible and shall be in accordance with the Contract Drawings and the following:
   a. Secondary wiring shall be SIS insulated, extra flexible copper wire, bundled and secured with nylon ties and routed within ventilated wire troughs or routed on insulated standoffs.
   b. Secondary wiring shall be No. 16 AWG minimum for instrumentation circuits, No.14 AWG minimum for control, No.12 AWG for potential transformer circuits and 10 AWG for current transformer and shunt trip circuits.
   c. All secondary wiring shall be marked at both ends with permanent labels to show the origin and destination.
   d. All current transformer secondary leads shall first terminate at accessible shorting terminal blocks before connection to any device. Shorting screws with provision for storage shall be provided.
   e. All secondary wiring shall terminate in terminal blocks where all field connections shall be made.
   f. All device terminals shall be terminated at terminal blocks.
   g. All field connections shall be made on one side of the terminal block and the side shall correspond to all terminal blocks.
   h. Terminal blocks shall be provided with suitable numbering strips and terminations shall be grouped as to function.
   i. All control wires intended for connection to remote panels shall be factory wired internally from each breaker to a common terminal block in each compartment. Connections shall then be made from compartment terminal blocks to marshalling terminal blocks in each half of the switchgear such as I/O compartments or sections.

I. Accessories
   1. Control Power Sources
      a. The switchgear shall include a 120-volt AC source suitable for operation as required of circuit breakers, meters, and status lights.
      b. The 120-volt source shall be distributed to the switchgear devices from a UPS backed panelboard.
   2. Pull Fuses
      a. The switchgear shall be equipped with pull fuse disconnects for the power sources.

b. The pull fuse disconnects shall be of the current interrupt disconnect block type with a fuse holder section in the removable pull out head.

c. The rating of the pull fuse disconnects shall be as shown on the Contract Drawings.

3. Surge Protective devices (SPD)

a. Each Buss of the Switchgear shall be equipped with an integral SPD. SPDs shall:

1) Comply with Section 26 43 13 – Low-Voltage Surge Protective Devices.

2) Be fed by its own circuit breaker or disconnect.

3) Have a minimum short circuit withstand rating of amps per phase as required by the Industry Standards.

4) Be capable of displaying its status without accessing the interior of the switchgear.

4. Metering

a. The switchgear shall include bus or feeder metering.

b. The bus metering shall consist of three current transformers, ampere ratio as shown on the Contract Drawings, and a microprocessor-based meter device.

c. The meter device shall include self-contained potential transformers and internal fuses, and shall include the following direct reading metered values:

1) Current, each phase and each line.

2) Voltage phase to phase and phase to neutral.

3) Power each phase and totalized value for all phases.

4) Reactive Power each phase and totalized value for all phases.

5) Total VA. each phase and totalized value for all phases.

6) Power factor each phase and totalized value for all phases.

7) Power, Reactive power, and Total VA demands each phase and totalized value for all phases.

8) Voltage and Current Harmonic up to the 50th harmonic.

9) Frequency with an accuracy of plus or minus 0.5%.

10) Percent THD and TDD.

d. Unit shall have the capability to communicate all measured and computed values to remote points on or off the switchgear.

5. Breaker Status and Parameter Monitors

a. The switchgear shall include an electronic interface module.

b. The module shall permit central monitoring and display of each circuit breaker trip unit parameters.

c. The module shall also communicate information from the protective and energy monitoring type trip units over a remote monitoring network or local monitoring and setting device.

d. The module shall permit configuration, display and testing features and shall include the following displayed parameters.

1) Phase and average demand current.

2) Present and peak demand watts.

3) Energy.

4) Trip information.

5) Percent THD.

6) Percent harmonic content.

6. Remote Electronic Communication

a. The switchgear shall contain all the equipment necessary to permit all values generated by metering devices and breaker status and parameter monitors to be transmitted to local devices on the switchgear or remotely.

b. All remote transmitting devices shall have the relevant interfaces to interconnect the switchgear devices communication protocols with site communication protocols.

7. Safety Grounding Provisions

a. For maintenance grounding provisions, ball studs shall be installed on the buses in accessible locations near access doors and shall be spaced on 6” centers.

b. Two (2) ball studs shall be installed in each location specified. The same number of studs shall be installed on both the ground bus and each phase bus.

c. Ball studs shall be minimum ASTM F 855 Grade 5, tin plated bronze alloy with a 1-inch ball, rated 43,000 amps for 15 cycles and 30,000 amps for 30 cycles.

d. Ball studs shall be furnished with removable covers and sufficiently spaced to meet uninsulated clearance for 600VAC Class.

e. Ball stud locations shall be:

1) On the stationary ground bus in the circuit breaker compartments.

2) On the stationary ground bus in the cable compartments.

3) On the feeder cable termination bus in the cable compartments.

8. Infra-red Inspection Windows

a. The rear doors of each switchgear section with power cable termination or bus connections shall be equipped with an infrared inspection system for thermo-graphic inspection of the power cable terminations or bus connections with the door closed.

b. The system shall be positioned such that all the power cable terminations or bus connections are visible through the lens.

c. The system shall consist of an infrared lens of 2-inch (50-millimeter) diameter minimum and mounting hardware.

9. Nameplates

a. Nameplates shall clearly indicate information in accordance with NEMA and IEEE requirements.

b. Nameplates shall be engraved or embossed on stainless steel.

c. The switchgear shall have identifying nameplates in accordance with the requirements of Section 26 05 53 Identification for Electrical Systems.

d. Nameplates shall clearly indicate information in accordance with NEMA and IEEE requirements.

e. A master nameplate shall also be provided mounted on the assembly.

f. The master nameplate shall identify switchgear designation, voltage, ampere and short circuit rating, manufacturer’s name, general order number and item number.

10. Arc Flash Mitigation

a. The switchgear shall be equipped with energy-reducing arc flash mitigation system. The switchgear shall have Arcflash Reduction Maintenance System with integral selector switch with (5) five arc-flash reduction settings. The Contractor shall provide switchgear arc energy reduction system documentation to the Engineer.

11. Mimic Diagram

    a. A Mimic Diagram representing the single line diagram of the switchgear shall be painted or affixed to the front elevation of Mimic Panel.

    b. The diagram shall begin with the incoming feeders, incorporate graphic representations of all the main elements of the switchgear that are fed or within the switchgear, such as transformers and breakers, and terminate in graphic or labeled representations of loads fed by the switchgear.

12. Mimic Panel

    a. A standalone remote control panel (Mimic Panel) shall be provided as shown the Contract Drawings. This mimic panel shall be part of the LV switchgear mimic panel.

    b. It shall be possible to execute from the Mimic Panel all the operations an operator can accomplish while standing directly in front of the switchgear such as opening and closing breakers and verification by status indicators.

    c. The Mimic Panel shall have a Mimic Diagram as described in this Section, except that all graphic representations of circuit breakers shall be replaced by actual breaker control switches one for each breaker, along with corresponding breaker and device status indicators.

    d. All indicator lamps shall be low burden LED type with power taken from the same source as the switchgear.

    e. All breaker control switches shall be of the same make and model as used on the switchgear.

    f. Metering indicators on the Mimic Panel shall be furnish and derive with displayed values from the devices installed in the switchgear via Communication circuits defined in this Section.

    g. The Mimic Panel shall be fabricated in UL listed panel shop.

    h. The panel shall be NEMA Type 12.

    i. The panel shall be an enclosed, front accessible and fabricated from reinforced sheet steel.

    j. Arc Flash Study submittals shall demonstrate that operations at the Local Mimic Panels do not represent a direct exposure to arc blasts energies from the front or rear of the switchgear lineup for any of the controlled breaker.

13. Insulating Floor Mat

a. The Contractor shall furnish and install non-conductive floor mat in front of the switchgear to provide insulation for the workers.

b. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

J. Master Controls

1. Redundant PLCs shall be provided and configured in hot standby arrangements.

2. Power Management Systems

a. Master controls systems shall include Load Bus Optimization and Generator Load Demand. Systems shall dynamically adjust to accommodate a segmented main bus or a single main bus as tie breakers open or close.

b. Load Bus Optimization shall control up to 128 individually prioritized and separately controlled distribution loads via electrically operated circuit breakers. Loads shall be added or removed from a bus segment according to the available headroom on the bus.

c. Generator Load Demand shall control up to 32 individually prioritized and separately controlled engine-generator sets. Engine-generator sets shall be added or removed from a bus segment according to dynamic measurements of power consumption and engine-generator efficiency set-points.

3. Manual Paralleling Controls

a. A Synchroscope selector switch shall be provided to select any generator for manual paralleling operation. The positioning of the selector switch shall simultaneously connect the synch-check relay, Synchroscope, and “manual paralleling” push-button to the selected generator.

b. A solid-state sync check relay shall be furnished for manual paralleling, to sense and compare the phase angle difference between the Incoming generator and the bus. This relay shall lockout the manual paralleling push-button until the Incoming generator is within 5 degrees of synchronism.

c. Operation shall be arranged so the operator shall depress and hold the manual paralleling push-button. When the relative phase angle reduces to 5 degrees and going towards zero degrees, the sync check relay’s output contact shall initiate the closing of the respective Incoming generator breaker.

d. The manual paralleling interface controls and metering shall be grouped in a central location on the front of the master control section. This shall allow for paralleling multiple generators from one location within the switchgear. Manual paralleling controls and sync check

relay shall be hardwired and shall not rely on touch screens or programmable logic controllers to perform manual paralleling functions.

4. DC Control Power Selector – Battery System

   a. Control power for the system logic shall be derived from the engine starting batteries and/or an optional station battery system. The control logic shall be powered through a suitable means that shall permit continuity of power until the last battery is no longer available. The controls shall be powered from any battery or combination of batteries and prevent feedback to a failing battery. The transition of control logic power from any battery combination to any other battery combination shall be accomplished without disruption in the power flow.

   b. DC-to-DC converters shall provide a constant 24VDC power to the master and generator controllers during starting and cranking of all engine generator sets “simultaneously”.

   c. The battery system shall provide power to the PLC Manual Override Panel.

5. System Test Switch

   a. Provide a system no-load test switch to initiate a complete automatic system operation by simulating the closure of the remote engine start signal. This switch shall be mounted inside the master section to limit access to authorized personnel only.

6. Main Bus Monitoring

   a. Main bus monitoring for each generator bus segment shall include a discrete Bus Under/Overvoltage Relay, a discrete Bus Under/Over-Frequency Relay and a Main Bus Power Watt Transducer.

7. Master Controller

   a. The master programmable logic controller shall be programmed by manufacturer and shall meet or exceed the requirement of this Specifications and sections:

      1) CPU, power supply, I/O, and communications.

      2) The controller shall have the capability to interface to a remote I/O rack.

8. Master PLC Redundancy

   a. This system shall consist of synchronized programmable logic controllers and common I/O systems between the controllers. Normally, the primary controller shall be the active one that controls

the system I/O while secondary controller(s) shall be on hot standby, ready to take control of the system I/O. Any single failure to the active controller shall cause automatic switch over to the standby controller. As both controllers shall be synchronized, there shall be a transfer from one controller to the other without interruption. The I/O shall be held in their current state during the transfer.

b. If the active controller fails and control transfers to the standby controller, the failed controller can be turned off and repaired without affecting the rest of the system.

c. Status indicators shall indicate which controller is active and if a controller is in run or stop mode.

K. Operator Interface Terminals (OIT)

1. The monitoring and control interface shall include programmable 24" color touch screen units and shall interface with Controllers, Synchronizer/Load Controllers, and Power Meters. The automatic operation of the system shall not be impeded by the unavailability, disconnection or failure of any single or all color touch screens.

2. The default screen shall consist of a one-line overview of the system that includes:

a. Dynamically updated and color-coded (according to status) one-line representing power flow and sources, and emergency power system elements such as engine-generator sets, circuit breakers (including breaker position and alarms), switchgear assemblies, and transfer switches (including transfer switch position, source availability, and bypass position).

b. Communication status of PLC(s)

c. Generators and transfer switches shall, when selected, link to a separate screen showing detailed status and alarm information ("drill down screens")

d. Main menu buttons, buttons linking to user guides, and buttons that link to other screens

e. Common alarm status including number of active alarms, number of unacknowledged alarms, and a flashing warning indicator if there are active alarms

f. The current KW value of all main and tie breakers

g. Color legend, abbreviation legend, and customer logo

3. Drill down screens shall include:

a. A dynamically updated mimic of the Master Status Panel.

b. Generator status panels shall mimic the actual switchgear panels including dynamically updated color indications and signal nomenclature.

c. Generator control stations shall mimic the actual switchgear control stations with fully functional engine control switch and synchronizing mode switch.

d. Metering screens shall include a photographic image icon of the actual meters and dynamically updated parameters that are available from the meter (voltages, currents, power measurements) and configuration parameters (PT connection, PT ratio, CT ratio).

e. Synchronizer/Load Share controller screens shall include a photographic image icon of the actual controller and dynamically updated parameters that are available from the controller such as metering status (voltages, currents, power measurements) and synchronization status (frequencies, voltages, synchroscope).

f. Transfer Switch drill down screens shall include details of Automatic Transfer Control (ATC), including present status and position, source availability, time delay settings, and metering data.

4. The monitoring and control interface screens shall also include:

a. A load management screen which shall dynamically indicate the current load demand status and provide operator controls to change settings (password protected). Each generator shall be represented and include “pick up” and “drop out” information and parameters (user-defined time delays, current timer status, and actual power) to manage loading of all engine-generator sets.

b. A bus optimization screen which shall dynamically indicate application status (enabled/disabled), most recent step load added, next available step load information, headroom, and priority load shed controls.

c. A generator priority screen for load demand.

d. An alarm summary screen with a current listing of all active alarms up to 500 entries and option for operator to acknowledge alarms (password protected)

e. An alarm history screen with up to 500 entries and a button linking to folder containing archive of 3 months or longer.

f. A communication status screen with network connections color-coded and dynamically updated

g. Historical trending of up to 10 parameters (phase currents; average current; average line-to-line voltage; total apparent, real, and reactive power; frequency; power factor) for 3 months or longer. Buttons shall be provided to zoom in and out as well as recall historical data and fast forward up to the current time. Plots shall display up to 8 curves concurrently.

5. Security

a. Security features shall include definition of at least three distinct security levels (monitor, control, manage) and a unique user name and password for each individual. Each individual account shall also be assigned to a security level thereby defining the scope of their access and control. Logging into or out of the system shall be an event entered into the alarm history. Each operator-triggered alarm shall be logged as an alarm history entry with the operator identity included. If an individual is logged in to the system with no activity for 30 minutes, the individual shall be automatically logged out.

b. On loss of screen communication, the operator must be able to take control at any time; systems that utilize “instant auto” features shall be excluded.

c. Screens shall be turned off (power standby mode) after 30 minutes of inactivity to protect the LCD monitor; a single touch of the screen shall turn the screen back on.

L. Generator Control System

1. Paralleling controls for each generator shall include a programmable logic controller (PLC) and a digital synchronizer and load controller designed for use on three-phase AC generators and mounted in the switchgear. The controls shall combine a synchronizer (with voltage matching capability), load sensor, load control, dead bus closing system interlock, VAR, power factor and process control. The load sharing network and VAR sharing network shall be completely integrated in the switchgear. Applications shall allow up to 32 generators to be paralleled and controlled.

2. The controls shall sense true RMS power and provide soft loading and unloading functions on the main bus.

3. DC-to-DC converter(s) shall be in each generator control section to provide a constant 24VDC power. The generator section DC-to-DC converter shall supplement the DC-to-DC converter in the master control section. Control power shall be sourced from generator set batteries and sustain adequate control voltage during an engine crank. The converters shall provide power for up to 75% rated load if the source voltage drops to 12 volts. Source voltage shall not exceed 32 volts.

4. Generator controls shall include the following functions, components, devices, and indicators.

   a. Reverse Power Protection (Device 32R)

   b. Generator Voltage Monitoring and Frequency Monitoring:

      1) Generator controls shall monitor voltage and frequency to ensure the generator is not connected to the bus until frequency is at least 59 Hertz and 90% rated voltage.

   c. Automatic Synchronizer:

      1) The synchronizer shall include a differential voltage detector, differential frequency detector and differential phase detector. Analog voltage bias signal shall be provided for voltage matching and an analog speed bias signal shall be provided for frequency matching and phase angle control. Synchronizer shall issue a breaker close signal when frequency, phase and voltage conditions are met.

      2) The differential voltage detector shall compare the voltage of the Incoming generator to the paralleling bus. If the voltage is not within the factory set difference of plus or minus 5% (adjustable from 0 to plus or minus 10%), the voltage detector shall inhibit the circuit breaker from closing. When the Incoming generator voltage is within the preset acceptable limit, the inhibit shall be removed.

      3) The differential frequency detector shall compare the frequency of the Incoming engine generator set to the paralleling bus. If the frequency is not within the preset acceptable difference of plus or minus 0.5 Hz (adjustable from 0 to plus or minus 0.5 Hz), the frequency detector shall inhibit the circuit breaker from closing. When the Incoming engine generator frequency is within the acceptable limit, the inhibit shall be removed.

      4) The differential phase detector shall compare the phase angle of the Incoming engine generator set to the paralleling bus. If the phase angle is not within the preset acceptable difference of plus or minus 0.05 Hz (adjustable from plus/minus 0.02 to 0.25 Hz), the phase detector shall inhibit the circuit breaker from closing. When the Incoming engine generator phase angle is within the acceptable limit, the inhibit shall be removed.

5. Multiple Circuit Interlock

a. Generator controls shall provide for first-up, first-on operation of the generator set. This device shall positively prevent more than one set from being simultaneously connected to a dead bus. Upon initiation of the connection of the first set to the bus, this circuit shall shift the control of the remaining sets to automatic or manual synchronizing at the operator's discretion.

M. Engine Starting Control

a. The engine starting control shall be in a dedicated programmable logic controller and shall automatically start, protect, and monitor each engine generator set. The controller shall be provided with power supply, CPU and required I/O modules. Engine start control shall additionally be hard wired so that the engine can be automatically or manually started if the controller is not available. The programmable logic controller shall be dedicated for control exclusively of the engine and generator set and shall be independent of the Master PLC. Distributed I/O systems which rely on a master controller shall not be acceptable.

b. To ensure optimum compatibility with the governor control, the synchronizer shall be by the same manufacturer as the governor control system or approved equal with a proven performance record.

c. Engine Start/Stop Operation

1) The automatic engine control logic shall initiate operation of the engine upon receipt of a signal from a contact that closes for engine run, and opens for engine stop.

d. Five Position Engine Control Selector Switch:

1) Lockout/Reset: When placed in this position, the engine shall not be capable of starting and/or running. If the engine was shut down due to the operation of a protective device, the shutdown shall be reset when the switch is moved to this position. If the engine is running when the switch is moved to this position, it shall immediately shut down.

2) Off/Cooldown: When placed in this position, the engine shall shut down after soft unloading from the bus (provided another source is connected to the bus) and a cool-down period.

3) Automatic: When placed in this position, the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.

4) Test Off-Line: When placed in this position, the engine shall start and run as if a start signal were received except it shall not be connected to the bus. If a start signal is received, normal automatic functions shall resume. When returned to the Automatic position, the engine shall shut down.

5) Test On-Line: When placed in this position, the engine shall start, run, and connect to the bus. When returned to the Automatic position the circuit breaker shall open, provided no automatic start signal is present, and the engine shall run for its cool-down period before shutting down.

e. Four Position Synchronizing Mode Selector Switch:

1) Permissive: In this position the governor controls are deactivated. However, the synchronizer shall operate as a passive synch check relay and signal the closing of the generator breaker when both sources are in phase.

2) Check: In this position the synchronizer is fully operational except it cannot close the generator breaker. The phase-lock feature holds the generator output in synchronism with the bus.

3) Off: In this position the synchronizer is turned off to allow for manual paralleling at the Master Cubicle.

4) Run: In this position the synchronizer is in the fully operational, automatic mode.

f. Engine Cooldown Time Delay

1) The cooldown time delay shall be adjustable from 1 to 10 minutes (factory set at 5 minutes) and automatically bypassed for malfunction and manual shutdown of the engine generator set.

g. Failure to Synchronize Time Delay

1) The failure to synchronize time delay shall be fixed at 60 seconds. It shall provide audible and visual indication, but it shall not terminate synchronizing attempts nor shut down the engine.

N. Operating Modes

1. Emergency Mode

a. Whenever the individual engine generator control switches are placed in their automatic position, the Paralleling Switchgear shall be on

standby in readiness for automatic starting and synchronization in the event of a power failure signal.

b. In the event of a power failure, all generator(s) automatically start and come up to speed. The first generator set to achieve 90% of nominal voltage and frequency shall be connected to the bus. Electronic interlocks permit the connection of only one engine generator to the dead generator bus in the event of simultaneous generator relay operation. Upon sensing the availability of emergency power, the priority load shall be allowed to energize their loads to the emergency bus per Specification Section 26 23 23 - Low-Voltage Switchgear. The synchronizer shall automatically adjust the frequency of the on-coming generator(s) to synchronize with the bus. When synchronism is achieved, the on-coming generator(s) shall be paralleled to the bus. When the second generator's circuit breaker is closed, another block of load shall be allowed to add, until all loads are online. The priority load energize order shall be as per Specification Section 26 23 23 - Low-Voltage Switchgear.

2. Block Load Control

a. Each load shall have an adjustable priority setting, estimated KW value and step time delay associated with it. As each block of load is allowed to energize to emergency power, the individual loads will begin their step time delay. As the time delay for each load completes, the load shall receive a permissive signal to energize to emergency power. If no delay is desired, the individual step times can be set to zero seconds, and the loads will energize immediately when the load block is permitted to energize to emergency.

b. If a generator fails while operating in the automatic mode, it shall be disconnected from the bus and shutdown. Audible and visual alarms must be activated to indicate the condition. System loads will not shed unless a bus overload or a bus under frequency occurs.

c. A push-button shall permit override of the load-shed circuits for supervised operation (one for each priority except priority 1). Loads that have been block shed can be manually re-added using the priority-# Load Shed Bypass/Reset push-button located on the Master control section. By pressing the Load Shed Bypass/Reset push-button, the system will energizer the selected load block to the emergency bus. By pressing the Load Shed Bypass/Reset push-button a second time, the entire selected load block will shed. Indicating lights shall annunciate the status of each Priority load block, indicating if it is shed or manually bypassed. If the operator inadvertently bypasses the load shed and overloads the generator(s) resulting in a bus under-frequency, all

manually bypassed loads shall be automatically shed along with blocks of load such that the remaining load blocks shall be one less than the number of generators remaining on the bus. The “Bus Under Frequency” annunciator light must indicate this condition.

d. If the online load exceeds 105% of rated generator capacity, unsupported loads (loads in priority blocks greater than the number of generators online) shall be step shed in reverse priority at one second intervals. No loads in priority blocks equal to or less than the number of generators online will be shed. The Bus Overload light will light to indicate that the bus is overloaded automatically reset as the overload is corrected. When the online load no longer exceeds 105% of the generator capacity, step shedding shall cease, and the system will continue to power the loads that are left online. Indicating lights shall annunciate the status of each Priority load block, indicating if any loads in that block are shed or if the load block is manually bypassed. If the operator bypasses the load shed to bring those shed loads back online, and the online load exceeds 105% of capacity again, the system shall again step shed loads in reverse priority until the load no longer exceeds 105% of capacity.

O. Features

1. Load Bus Optimization

a. Each load must be capable of being programmed with a load priority value (field adjustable, accessible via the OIT on the master section door).

b. Should a Priority Block fail to be added to the bus while operating in the Emergency Mode, loads may be added manually by the operator as described above in section B. Block Load Control.

c. With the Bus Optimization switch in the "on" position during emergency mode and with loads shed (loads requiring power but are not connected to the emergency bus), after a stabilization time delay (Bus Opt stable delay) the optimization feature shall be activated and a Bus Optimize Active light illuminates.

d. If it is determined that the load can be added without exceeding the Bus Optimization KW de-rating value, the load shall be signaled to add. The real time kW output of the generator bus is constantly measured and the next sub-priority load is evaluated. Loads are evaluated at a preset time interval defined via the OIT (Bus Opt Step Time). When the bus has been loaded to a level such that the next load would exceed the de-rating value, the Next Load Exceeds Headroom light will activate and load adding shall pause. The system will continuously monitor the

generator load and evaluate if the next load step can fit on the bus. If building load decreases and the next load can fit (for the duration of the step time delay), the system shall add it and continue the evaluation process until as many loads as possible are added to the bus.

e. If at any time, the online load exceeds 105% of available rated capacity, the system shall remove the last load that was added. If the online load does not decrease to less than 105% of rated capacity, loads must be shed one at a time, every second in reverse order until the overload is corrected or until the number of load blocks online equals the number of generators online. Load blocks with associated generators online will not be shed. The Bus Overload light shall light to indicate that the bus is overloaded automatically reset as the overload is corrected. In this event, the system will begin a 30 second overload stabilization delay time (fixed) before evaluating additional load to be added to the bus.

f. If a generator fails, it shall be removed from the bus. If the remaining loads online exceed 105% of the remaining online generator capacity, the loads must step shed as described in the previous paragraph. If the load does not exceed the online capacity, no loads need be shed. The Bus Overload light shall light to indicate that the bus is overloaded automatically reset as the overload is corrected.

g. In the event of a bus under-frequency, all optimized loads shall be shed as well as any additional unsupported blocks of load. Load blocks shall be shed such that the remaining load blocks shall be one less than the number of generators remaining on the bus. The “Bus Under Frequency” annunciator light will indicate this condition.

h. If a load block is manually bypassed, all loads in that block shall be added, subject to their individual step timers. If they were already optimized on, they will remain on. If the load block is then manually shed, all loads in that load block shall be shed.

i. Generator Load Demand Control

1) The Load Demand logic shall be capable of controlling the number of generating sets so as to remove excess generator capacity and add additional capacity when needed, thus keeping the optimum number of generators online at all times.

2. System Test

a. Load Test:

1) The system shall be capable of being tested from either the automatic transfer controls (at LV switchgear mimic panel)

test switch or the operator interface (OIT) located at the master section (as well as mimic screen if applicable).

b. No-Load Test:

1) A system test switch shall be mounted inside the master control cubicle to limit access to authorized persons only.

2) Operation of this switch shall start and parallel all generators. Unless a normal source outage occurs during this mode of operation, the automatic transfer control will not energize their load to the emergency bus.

c. Single Engine Test:

1) Each engine shall be capable of being started for test purposes by placing its generator control switch to the off-line position. In this mode, the generator paralleling circuit breaker will remain open.

2) Should a normal source outage occur during this mode of operation, the breaker shall close and the remaining units will be started. Upon restoration of normal power, the system will revert to single engine test mode until the switch is returned to the automatic position.

3) For on-line test, placing of the generator control switch to the on-line position shall present a similar operation except that the generator breaker will close when the generator achieves nominal voltage and frequency

d. Generator Load Bank Test:

1) The paralleling system shall be capable of testing the generator using the load bank. The load bank breaker must be manually closed by an operator after generator power is available on the bus. The operator will also have to operate their load bank controller to add load steps manually.

2) A form “C” contact is provided in the master section that needs to interface to the load bank controller which will automatically shed the load bank in the event of a power outage

e. Hand–Off–Auto Controls

1) The system shall be provided with (H-O-A controls) of the Auto Transfer Control (ATC) through the OIT. The individual loads can be controlled from the switchgear. After logging in to the OIT, the operator can select the load

to be brought online and place it in the HAND position via the pushbutton on the OIT touch screen. When placed in the HAND position, the load shed signal is removed and the load is allowed to energize to emergency power.

2) When the load is placed back into the AUTO position, the system shall be allowed to control the load normally for load adding and load shed controls.

3) Any load in the HAND position shall be returned to AUTO at the end of Emergency Mode.

4) When a load is placed in the OFF position, it shall never be allowed to energize to emergency. If the system is running in emergency mode, placing a load in the OFF position will immediately shed it from the emergency source.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. All metal surfaces of the switchgear/s shall be thoroughly cleaned and given one coat of zinc chromate primer.

2. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose lacquer enamel.

3. All exterior surfaces shall be given three coats of the same lacquer. The color of the exterior finishing coats shall be light gray ANSI No. 61.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Each switchgear shall be completely assembled, wired, and tested at the factory, including all buses, connections, insulator, terminals, and terminal blocks, to demonstrate that it has been properly manufactured, properly assembled, is not overheating, is not overloading and has no electrical or mechanical defects.

2. Shop testing shall be performed on the switchgear at the manufacturer's plant prior to shipment.

3. Shop test shall be in accordance with the latest revisions of IEEE and ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.

4. The Contractor shall provide a Certified Shop Test Report.

a. The report shall identify the tests performed and the results obtained.

5. Switchgear shop tests shall include the following:

a. Visual and physical inspection of the interior and exterior of the switchgear including all devices to verify consistency with approved submittals.

1) Check bus layouts and takeoffs confirm with approved submittals.

2) Check bus for proper electrical clearances.

3) Check tightness of all bolted and torqued connections.

4) Verify the polarity of all instrument transformers.

5) Verify the grounding of all instrument transformers.

6) Verify all nameplate engravings.

b. Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.

c. Continuity test shall be performed on power and control wires.

d. Functional operations test which shall include paralleling, pick up, dropout, time delay, sequence, and polarity.

e. Primary hi-potential tests shall be performed.

1) Primary current carrying parts shall be tested between phases, phase to ground, and line to load.

2) The applied voltage shall be twice rated voltage plus 1000 for 1 minute.

f. Hi-Potential tests on control and secondary wiring shall be performed.

1) Control circuit wiring shall be tested for 1500 volts to ground for 1 minute.

g. Power cables and buses shall be tested, for insulation breakdown resistance and circuit isolation.

1) Test voltage frequency shall not be less than the frequency of the rated voltage of the equipment tested.

h. Verify connectivity and communication of devices.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests.

3. For the Witnessed Shop Test the Contractor shall perform all the Certified Tests in the presence of the witnesses.
4. The Contractor shall submit a Witnessed Shop Test Report.
   a. The report shall identify the tests performed, the results obtained, contain all raw data sheets, certified test data, calibration certificates, punch lists and confirmation as to how punch lists items were resolved.
5. Switchgear shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine installation area to assure there is enough clearance to install switchgear.

B. Verify that installation will yield required working spaces around the switchgear installation.

C. Check concrete pads for uniformity and level surface.

D. Verify field measurements are as shown on the approved Shop Drawings.

E. Verify that required utilities are available, conduit stubs etc. are in required location and ready for use.

3.02 INSTALLATION

A. Switchgear and associated equipment and accessories shall be installed in accordance with manufacturer's instructions and recommendations.

B. Switchgear shall be bolted to the concrete bases and shall comply with seismic requirements of Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems and the NYS Building Codes.

C. Switchgear equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

D. Switchgear equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

E. Steel channels shall be provided for support of switchgear equipment.

F. Switchgear equipment shall be securely mounted to mounting surfaces with anchor bolts.

G. Identification

1. Identify field-installed conductors, interconnecting wiring, warning signs and components in accordance with Section 26 05 53 – Identification for Electrical Systems.
2. Label each switchgear compartment with nameplates complying with Section 26 05 33 – Identification for Electrical Systems.
3. Provide device nameplates complying with Section 26 05 33 – Identification for Electrical Systems.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Testing

1. After installation, the switchgear shall be field tested for operation and conformance.
2. Field testing shall conform to the requirements in this Section, Section 01 75 10 – Preliminary and Final Field Tests, NETA ATS, and the Manufacturer's recommendations.
3. Field tests shall be witnessed by the Engineer and certified by the Contractor.
4. The services of the switchgear manufacturer shall be retained for field testing.
5. Switchgear testing shall be supervised by the Manufacturer's representative, prior to energizing equipment.
6. Equipment shall not be energized without the permission of the Engineer.
7. Retain the service of an independent testing firm who shall perform field testing of the switchgear.
   a. The testing firm shall have experience in the inspection and testing of low-voltage switchgear equipment and shall be a member company of NETA.
   b. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

B. Preliminary Field Testing

1. Preliminary Field Test of the switchgear shall be in accordance with the recommendations of the manufacturer's representative, NETA ATS and shall consist at a minimum of the following:
2. Visual and physical inspections shall at a minimum verify the following:
   a. Verify all switchgear equipment are located according to approved submittals.

b. Verify all nameplates, tags, and identification marks in accordance with approved submittal and preliminary As Builts Drawings.

c. Physical, electrical, and mechanical condition shall be inspected.

d. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

e. Ventilating air passageways shall be inspected for blockage.

f. Mechanical interlock systems shall be checked for proper operation.

g. Insulators shall be inspected for evidence of damage or contamination.

h. Device settings and adjustments shall be verified.

i. Breakers and vertical sections shall be checked to determine that they have been properly installed, lubricated, and connected.

j. Equipment shall be cleaned and lubricated as required.

3. Electrical testing shall at a minimum include:

a. Test continuity of all circuits

b. All connections shall be inspected for high resistance.

c. Electrical interlock systems shall be checked for proper operation.

d. Ground-resistance tests shall be performed.

e. Perform resistance measurements through bolted connections with a low-resistance measuring device.

f. Perform insulation-resistance measurements on each bus section, phase-to-phase, and phase-to-ground for one minute.

g. An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

h. Contact-resistance test shall be performed.

i. Control and metering wiring performance test shall be performed.

j. Primary and secondary voltage and current injections shall be performed to confirm phasing, polarities, transformation ratios.

k. Circuit breaker trip characteristics shall be determined by primary current injection.

l. Control equipment and connections shall be checked to determine that they are not defective.

C. Preliminary Loading Tests

1. The Contractor may substitute load banks of the type and power factor which are approved by the Engineer to complete Preliminary Load Tests if the actual loads are not ready for energization.
   a. The full load rating of the load bank shall be comparable to that of the circuit loads under test.
2. Preliminary Loading Tests shall at the minimum include:
   a. Control voltages shall be applied and functional tests verifying the operations of all breakers, controls and displays.
   b. Primary voltage shall be applied to the complete primary bus via the switchgear main feeder breakers with tie breakers in the normal operating positions.
      1) The primary buses shall remain energized for one hour with no further operations.
         a) During this one hour period all voltage and potential transformer secondaries and circuits shall be checked for voltage magnitudes, phasing, phase sequence along with all associated metering displays.
      2) After one hour the tie breakers shall be closed facilitating the energization of the complete bus from either main feeder for one hour.
         a) During this one hour period all voltage and potential transformer secondaries and circuits shall be checked for voltage magnitudes, phasing, phase sequence along with all associated metering displays.
      3) Each switchgear distribution feeder breaker shall be closed for one hour to energize its associated load/load bank/feeder.
         a) During this one hour period all metering circuits shall be checked for voltage, current, voltamp, and var values, phasing, phase sequence along with all associated metering displays.
      4) All switchgear distribution feeder breakers shall be closed for one hour to simultaneously energize all loads fed by the switchgear.
         a) During this one hour period all metering displays shall be checked.

D. Infrared testing shall be performed once after initial energization of the switchgear and a second time after full load has been applied continuously for twenty-four (24) hours.

E. Switchgear Final Field Test

1. Switchgear Final Field Test shall be considered complete when all the outgoing circuits shall have energized their various loads for the Final Field Test of the respective load.

F. Any deficiencies or issues which may arise during Preliminary Field Tests, Preliminary Loading Test or Switchgear Final Field Test shall be remedied by the Contractor at no additional cost to the City.

G. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the switchgear, check the switchgear installation before it is placed into operation and assist in the performance of Preliminary and Final Field Tests.

2. The Manufacturer's representative shall provide switchgear equipment Start-up services and Training of the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the switchgear in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

a. Minimum number of manufacturer's representative site visits per low-voltage generator switchgear:

Visit Type	Minimum Number of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation & Inspection	1	3	4
Field Tests	1	3	4
Startup	1	2	3
Training	1	2	2

b. Additional trips or days that are required to achieve the proper installation, operation or training, such services shall be arranged for by the Contractor at no additional cost to the City.

c. The Engineer shall have the right to reallocate any unused time.

3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.
   a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.
   b. The switchgear manufacturer's representative shall certify in writing to the Engineer that the switchgear equipment has been installed, setup and tested properly in accordance with Contract requirements and is operating at optimum conditions and capacity.
4. The manufacturer representative shall also make any necessary adjustments and instruct the Site personnel in its operation and maintenance.
5. The service representative shall sign in and out with the Engineer on each day they are at the site.
6. A day shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. Switchgear Startup
   1. Switchgear Startup shall comply with the requirements of Section 01 79 05 – Startup and Training and shall be considered completed when all the loads on the switchgear completes their startup requirements.

B. Switchgear Training
   1. The Contractor shall provide Training on the switchgear in compliance with Section 01 79 05 – Startup and Training.
   2. The Contractor shall submit for approval by the Engineer, lesson plans identifying in detail, the training to be conducted.
   3. The Contractor shall coordinate training services with the City and the Engineer.
   4. The Contractor shall schedule training at least forty-five (45) days prior to delivery of training subject to the approval of the Engineer and the City.
   5. The training shall consist of both classroom and field instruction.
   6. The purpose of field instruction shall be to reinforce topics covered in the classroom and to identify the location of any control switches and other equipment required for operation; and to identify locations of any maintenance equipment.

7. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

8. The manufacturer's representative shall sign in and out at the office of the Resident representative on each day he is at the project.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing all new panelboards. Panelboards shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. Panelboards shall include all power distribution, lighting, appliance, and instrument panelboards.

C. The following index of this Section is included for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding.

B.	Section 26 05 48	-	Vibration and Seismic Controls for Electrical Systems
C.	Section 26 05 53	-	Identification for Electrical Systems.
D.	Section 26 05 73	-	Power System Studies.
E.	Section 26 05 75	-	Shock Hazard and Arc Flash Studies
F.	Section 26 06 11	-	Cable and Conduit Schedule.
G.	Section 26 43 13	-	Low-Voltage Surge Protective Devices.

1.04 REFERENCES

A.	NEMA PB1	-	Panelboards.
B.	NIST	-	US National Institute of Standards and Technology.
C.	NEC	-	National Electrical Code.
D.	NYSBC	-	New York State Building Code.
E.	UL 50	-	Enclosures for Electrical Equipment Non-Environmental Considerations.
F.	UL 67	-	Panelboards.
G.	UL 489	-	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
H.	UL 943	-	Ground Fault Circuit Interrupters.

1.05 DESCRIPTION

A. All panelboards shall be dead-front type with automatic trip-free, bolt-on, molded case circuit breakers.

B. All panelboards shall be equipped with main breakers, 1-pole, 2-pole, and 3-pole branch circuit breakers as shown on the Contract Drawings.

C. All panelboards shall be enclosed in flush or surface mounted cabinets as shown on the Contract Drawings.

D. Arc Flash Labels shall be provided for all panelboards in accordance with Section 26 05 75 – Shock Hazard and Arc Flash Studies.

E. All panelboard installation shall comply with Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems and applicable seismic requirements of the NYCBC.

1.06 QUALITY ASSURANCE

A. Panelboards shall be designed, built. and tested in accordance with the latest applicable standard editions of IEEE, NEMA, UL, the Utility and NEC.

B. The Panelboard manufacturer shall be the manufacturer of all the major components of the Panelboards as specified in this Section, the Specifications and as shown on the Contract Drawings.

C. All Panelboard shall be new within 6 months of manufacture and complying with the requirements of this Section, the Specifications, and the Contract Drawings.

D. The manufacturer of the Panelboard shall have produced Panelboards for a minimum period of the last continuous fifteen (15) years.

E. The Panelboard manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

1. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure that each Panelboard and its components are designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings.

F. Panelboard shall be UL listed.

G. Whenever applicable, all Work regarding the Panelboard equipment shall conform to the requirements of the Utility.

H. All cable and wire terminations at the panelboard shall be done by experienced installers who have worked with similar panelboard for a period of at least 5 years, using materials and procedures recommended by the panelboard manufacturer.

I. The Contractor shall provide list of at least five (5) installations with similar panelboard, to that which will provided under this Contract, and demonstrating compliance with these requirements.

1. The Contractor will provide the name, address, telephone number and email of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning, and operation of the panelboard equipment at the above listed five installations.

J. The Contractor shall retain the services of the Panelboard manufacturer's representative to certify that the Panelboard installation is in accordance with the manufacturer's requirements.

K. Where redundant/dual Panelboards are to be installed to confirm with Contract or Utility requirements, each Panelboard shall be physically separated from other Panelboards in conformity with Utility requirements and/or as shown on the Contract Drawings.

L. Seismic Requirements

1. The Contractor shall provide Panelboards designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems and the NYS Building Codes.

M. Testing

1. The Panelboard manufacturer shall use a shop test facility that has calibrated testing apparatus and qualified experienced technicians for all shop tests.
2. Calibration of all testing apparatus shall be within one year.
3. Shop testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.
4. Field testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.
5. All test equipment, instrument calibration and test reports shall be in accordance with the latest edition of the accuracy standard of NIST and NETA ATS.

1.07 SUBMITTALS

A. Contractor shall submit shop drawings and material specifications for approval by the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Certified copy of the manufacturer's Design Tests made in accordance with all applicable UL standards and conducted on Panelboard models and type that is being offered for this contract.
2. Certified dimensioned outline drawings showing panelboard layouts, front and side views and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.
4. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.
5. Weight of the Panelboard and all associated equipment and distribution on the foundation support of the static, impact, and other loads.
6. Erection drawings and procedures.
7. Single-line diagrams
8. Detailed Elementary, Schematic, Wiring and Interconnecting Diagrams.
9. Common Elementary and Interconnection Wiring Diagrams are not acceptable.
10. Wire lists in lieu of wiring diagrams are not acceptable.
11. Separate customized drawings for each Panelboard shall be supplied including individual point-to-point wiring diagram.

12. Complete Bill of Material.
    a. A listing of the panelboards with the number and size of circuit breakers identified.
13. Details of special features.
14. Instruction manuals of all protective devices.
15. Nameplate schedules.
16. Recommended spare parts list with pricing.
17. List of Special Tools.
18. Painting Procedures.
19. List of recommended lubricants.
20. Testing Submittals
    a. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted.
    b. Testing methods and procedures shall be submitted at least 90 days in advance prior to conformation of witness testing dates and actual testing.
    c. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least 90 days in advance of actual testing.
21. Seismic Criteria
    a. Calculations demonstrating compliance with Section 26 05 48 - Vibration and Seismic Controls for Electrical Equipment and NYS Building Codes.
    b. Panelboard anchorage details with design calculations signed and sealed by NYS Licensed Engineer.
22. Operation and Maintenance Manuals
    a. Preliminary Operation and Maintenance manuals.
    b. Finalized Operation and Maintenance manuals.
23. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the Panelboard satisfies the requirements stated in this Section.
    b. Seismic qualification certification from the manufacturer including mounting recommendations.
    c. Cybersecurity Equipment Certification

d. Data and results of witness tests shall be accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

24. Reports.

a. All certified and witnessed shop test reports.

b. All field test reports.

c. All manufacturer's Site visit reports.

C. The Contractor is responsible to make submissions of all applicable drawings, specifications, and studies to Authorities Having Jurisdiction (AHJs) and Utilities for approvals and review.

1. Where submissions are required to be made by a Professional Engineer, the Contractor shall secure these services at no additional cost to the City.

2. These submissions for approvals and review include those required by the NEC and administered by the local government, New York State Building Codes, and those of the Utility.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Panelboards shall be delivered, stored, protected, and handled in accordance with the manufacturer’s instructions, this Section, the Specifications and the manufacturer’s instructions and the following:

1. Panelboards shall be inspected when received, for shipping damage, water intrusion which may have entered the equipment during transit or loose parts and a report of any damage made to the carrier within the specified time.

2. Panelboards shall be shipped and delivered in convenient packages.

3. Each package split shall be mounted on shipping skids and wrapped for protection.

4. Shipping packages shall contain accessories to permit handling by cranes.

5. Exhaust systems

a. Exhaust channels and plenums intended for connection to the Panelboard rooms shall be packaged and shipped separately.

6. Panelboards shall be stored indoors in a well-ventilated, clean, level, dry and cool location with uniform temperature to prevent condensation.

7. Panelboard equipment shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.

8. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

9. Embedded electronics shall be shielded from harmful electrical and magnetic energy fields.

10. Panelboard equipment shall be lifted into locations shown on the Contract Drawings.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the Site and at such time as the Engineer may direct, spare parts, special tools and supplies for Panelboard in accordance with the requirements of this Section and the Specifications.

B. The Contractor shall furnish for the Panelboard, all spare parts, special tools and supplies as recommended by the manufacturer.

C. The spare parts, special tools and supplies shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

D. Furnish in addition the following spare parts for each Panelboard installation:

1. One spare key shall be provided for each key interlock system.

2. One (1) set of complete replacement power fuses for each size and type installed.

3. One (1) set of complete replacement indicating lamps for each type installed.

4. One (1) set of complete replacement color caps for each type installed.

5. One (1) of each type of protection relay for each type installed.

6. One (1) spare breaker for each size and type installed.

E. Furnish the following protective equipment and tools:

1. The Contractor shall furnish one (1) set each of protective equipment and tools for each of 10 Panelboards.

2. Personnel protective equipment shall confirm to the requirements of the BWS E&HS.

3. Personnel protective equipment required to satisfy the requirements of Section 26 05 75 - Shock Hazard and Arc Flash Studies shall at the minimum consist of:

a. Safety Goggles

b. Face shields

c. Protective Apron

d. Protective Overshoes

e. Carrying case for the above equipment

4. Furnish the following tools for each Panelboards installed:

a. One (1) sets of specialized wrenches and tools as required for proper installation, operation. and maintenance.

b. One (1) infrared inspection system for thermo-graphic inspection of the inter-cell cable, bus connections and terminations.

c. One (1) lifting device to permit transfer the heaviest Panelboard component from the Panelboard to mobile trucks or work tables.

5. Furnish the following supplies for each Panelboard:

a. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the Panelboard equipment furnished under this section for a period of one (1) year after acceptance.

1) Replace all lubricants used during start-up and testing prior to acceptance of equipment.

2) Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Panelboards shall be as manufactured by:

1. Schneider, Seneca, SC

2. Siemens, Washington, DC

3. ABB, Mebane, NC.

4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Panelboards

1. Ratings:

a. Panelboard frequency shall be 60 Hz.

b. Panelboard ampacities, voltage, number of phases and wires shall be as shown on the Contract Drawings.

c. Panelboards shall be labeled with a UL short circuit rating. All panelboards shall be fully rated.

d. Available short circuit infeed at the panelboard shall be no more than seventy percent of the panelboard short circuit rating.

e. Panelboards rated 240VAC or less shall have a minimum short circuit rating of 10,000A RMS symmetrical, unless shown otherwise on the Contract Drawings.

f. Panelboards rated 480VAC shall have a minimum short circuit rating of 14,000A RMS symmetrical, unless shown otherwise on the Contract Drawings.

2. Cabinets:

a. Cabinets shall be constructed of 12-gauge galvanized steel with stainless steel hardware and with pocket.

b. Cabinets shall be NEMA 12 for dry, indoor areas and NEMA 4X for corrosive areas. In hazardous locations, panelboards shall have a NEMA 7 rating.

c. Cabinets shall have wiring gutters on the sides.

d. Cabinets shall be at least 5-3/4 inches deep and 20 inches wide for panelboards with maximum branch circuit breakers of 100A. When branch circuit breakers are above 100A, cabinets shall be at least 9-1/2 inches deep and 31 inches wide.

e. Trims for panelboards shall consist of a hinged trim door which does not leave any live parts uncovered and permits the operation of all circuit breakers. In addition, a door-in-door arrangement shall form the dead front panel door covering all parts not covered by the hinged trim door. Both doors shall have concealed hinges with flush type catches and locks. All locks shall be keyed alike.

f. Cabinets shall have identifying nameplates in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems.

3. Bus Bars:

a. Bus bars shall be copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.

b. Bus bar taps for single-pole branches shall be arranged for sequence phasing of the branch circuit devices.

c. A bonded ground bus shall be included in all panels.

d. Full-size neutral bars shall be provided for panelboards, unless noted otherwise on the Contract Drawings.

e. Panelboards shall be provided with a 200 percent rated neutral bus suitable for use with non-linear loads. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

4. Circuit Breakers:

a. Circuit breakers shall be the molded case type conforming to UL 489.

b. Breakers shall be the heavy-duty, bolt-on type with quick-make quick-break toggle mechanism for manual as well as automatic operation.

c. Breakers shall have 100-amp frames, with 15-amp trip elements as minimum, unless otherwise shown on the Contract Drawings.

d. All 100-amp frame breakers shall be fixed thermal magnetic trip units.

e. Frame sizes above 100 amps shall have interchangeable thermal magnetic trip units or electronic trip units.

f. Breakers shall be provided with electronic trip units. Electronic trip units shall provide long time, short time, instantaneous and ground fault settings, and time adjustments as a minimum.

g. Ground fault circuit interrupters shall be provided. Ground fault breakers shall be equipped with solid state sensing and 5 milliamp sensitivity.

h. Breakers used for lighting circuit switching shall be suitable for the purpose and shall be marked "SWD". Breakers requiring continuous operation shall be provided with a lock-on device.

i. Bell alarms, and auxiliary devices shall be provided.

5. Metering:

a. A UL listed microprocessor metering unit (MU) shall be installed in the panelboard.

b. The MU shall have the capability to monitor all the panelboard outgoing and spare circuits including capacity for an additional twenty percent spare circuits.

c. The MU shall be able to monitor and time stamp at a minimum the following per phase and line values for each circuit:

1) Voltage, Current, Power, Power Factor, VAR, and Frequency.

2) Watt Hour and Var Hour both forward and reverse.

d. The MU shall be able to auto-detect sensor rating.

e. The MU shall store the energy profile for each circuit in a non-volatile memory for a minimum of one year. The demand interval shall be 15 minutes.

f. MU communications ports and protocols shall be consistent with those adopted for the site or facility and shall be as stated in the Specifications or as shown on the Contract Drawings.

6. Surge Protection:

a. The panelboard shall be provided with surge protective devices complying with Section 26 43 13 – Low-voltage Surge Protective Devices.

7. Directories:

a. Each panel shall be provided with a directory.

b. The directory shall be protected by a glass or noncombustible plastic cover.

c. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service and the number of spares.

1) This directory shall be updated as work progresses, and final, typewritten directories shall be provided at the end of the Contract.

d. Where execution of the work under this Contract requires certain circuits to be modified, the Contractor shall update or provide panelboard directories to reflect the modifications.

1) Final typewritten directories shall be provided at the end of the Contract.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. All metal surfaces of the panelboard enclosures shall be thoroughly cleaned and given one coat of zinc chromate primer.

2. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose enamel lacquer.

3. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be light gray ANSI No. 61.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Each Panelboard shall be completely assembled, wired, and tested at the factory, including all buses, connections, insulator, terminals, and terminal blocks, to demonstrate that it has been properly manufactured, properly assembled, is not overheating, is not overloading and has no electrical or mechanical defects.

2. Shop testing shall be performed on the panelboard at the manufacturer's plant prior to shipment.

3. Shop test shall be in accordance with the latest revisions of UL, IEEE and ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.

4. The Contractor shall provide a Certified Shop Test Report.

   a. The report shall identify the tests performed and the results obtained.

5. Panelboard shop tests shall include the following:

   a. Visual and physical inspection of the interior and exterior of the panelboard including all devices to verify consistency with approved submittals.

      1) Check bus layouts, breaker types, sizes and quantities confirm with approved submittals.

      2) Check bus for proper electrical clearances.

      3) Check tightness of all bolted and torqued connections.

      4) Verify all grounding provisions.

      5) Verify all nameplate engravings.

   b. Mechanical operations shall be performed to insure proper functioning of operating mechanisms and interchangeability.

   c. Continuity test shall be performed on power and control wires.

   d. Functional operations test which shall include pick up, dropout, time delay, sequence, and polarity.

   e. Primary hi-potential tests shall be performed.

      1) Primary current carrying parts shall be tested between phases, phase to ground, and line to load.

      2) The applied voltage shall be twice rated voltage plus 1000 for 1 minute, 1500 volts minimum.

   f. Verify connectivity and communication of devices to be connected to the EMCS.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.
2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests
3. For the Witnessed Shop Test the Contractor shall perform all the Certified Tests in the presence of the witnesses.
4. The Contractor shall provide a Witnessed Shop Test Report.
    a. The report shall identify the tests performed, the results obtained, contain all raw data sheets, certified test data, calibration certificates, punch lists and confirmation as to how punch lists items were resolved.
5. Panelboard shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine installation area to assure there is enough clearance to install panelboard.

B. Verify that installation will yield required working spaces around the panelboard installation.

C. Check installation surfaces for uniformity and level surface.

D. Verify field measurements are as shown on the approved Shop Drawings.

E. Verify that required utilities are available, conduit runs etc. are in required location and ready for use.

3.02 INSTALLATION

A. Panelboards shall be mounted rigidly and securely to the building structure or to supporting devices which are rigidly and securely supported by the building structure.

B. Anchor panelboards in accordance with Section 26 05 48 – Vibration and Seismic Controls for Electrical Equipment and the NYCBC.

C. Panelboards shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on metal.

D. Mount all panelboards parallel or perpendicular to walls, such that panelboards are installed in a neat and professional manner.

E. All wiring shall be neat within the panelboards. Wires shall be run vertically in the wire gutter and then terminate horizontally at a breaker.

F. The Contractor shall install blanking devices within panelboard spaces, so bus bars are not exposed.

G. Install panelboard nameplates for identification of equipment.

H. Panelboard circuits shall be installed so to balance the loads on each of the phases.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Testing

1. After installation, the panelboard shall be field tested for operation and conformance.

2. Field testing shall conform to the requirements in this Section, Section 01 75 10 – Preliminary and Final Field Tests, NETA ATS and the Manufacturer's recommendations.

3. Field tests shall be witnessed by the Engineer and certified by the Contractor.

4. The services of the panel manufacturer shall be retained for field testing.

5. Panelboard testing shall be supervised by the Manufacturer's representative, prior to energizing equipment.

6. Equipment shall not be energized without the permission of the Engineer.

7. Retain the service of an independent testing firm who shall perform field testing of the panel board.

8. The testing firm shall have experience in the inspection and testing of panelboard equipment and shall be a member company of NETA.

a. Provide proof of membership or demonstrate that the standards and experience required for membership are possessed, all to the satisfaction of the Engineer.

B. Preliminary Field Testing

1. Preliminary Field Test of the panelboard shall be in accordance with the recommendations of the manufacturer's representative, NETA ATS and shall consist at a minimum of the following:

2. Visual and physical inspections shall at a minimum verify the following:

a. Verify all panelboard equipment are located according to approved submittals.

b. Verify all directories, nameplates, tags, and identification marks in accordance with approved submittal and preliminary As Builts.

c. Physical, electrical, and mechanical condition shall be inspected.

d. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

e. Ventilating air passageways shall be inspected for blockage.

f. Mechanical interlock systems shall be checked for proper operation.

g. Insulators shall be inspected for evidence of damage or contamination.

h. Breaker settings and adjustments shall be verified.

i. Breakers and vertical sections shall be checked to determine that they have been properly installed and connected.

j. Equipment shall be cleaned as required.

3. Electrical testing shall at a minimum include:

a. Test continuity of all outgoing circuits.

b. All connections shall be inspected for high resistance.

c. Electrical interlock systems shall be checked for proper operation.

d. Ground-resistance tests shall be performed.

e. Perform resistance measurements through bolted connections with a low resistance measuring device.

f. Perform insulation-resistance measurements on each bus, phase-to-phase, and phase-to-ground for one minute.

g. An over potential test shall be performed on each bus, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

h. Control and metering wiring performance test shall be performed.

i. Circuit breaker trip characteristics shall be determined by primary current injection.

j. Control equipment and connections shall be checked to determine that they are not defective.

C. Preliminary Loading Tests

1. The Contractor may substitute load banks of the type and power factor which are approved by the Engineer to complete Preliminary Load Tests if the actual loads are not ready for energization.

a. The full load rating of the load bank shall be comparable to that of the circuit loads under test.

2. Preliminary Loading Tests shall at the minimum include:

a. Primary voltage shall be applied to the complete primary bus via the panelboard main breakers.

1) The primary bus shall remain energized for one hour with no further operations.

a) During this one hour period, all voltage circuits shall be checked for voltage magnitudes, phasing, phase sequence along with any associated metering displays.

2) Each panelboard circuit breaker shall be closed for one hour to energize its associated load/load bank/feeder.

a) During this one hour period. all circuits shall be checked for voltage, current, voltamp, and var values, phasing, phase sequence along with any associated metering displays.

3) All panelboard circuit breakers shall be closed for one hour to simultaneously energize all loads fed by the panelboard.

a) During this one hour period all metering displays shall be checked.

D. Infrared testing shall be performed once after initial energization of the panelboard and a second time after full load has been applied continuously for (24) hours.

E. Panel Final Field Test

1. Panel Final Field Test shall be considered complete when all the outgoing circuits shall have energized their various loads for the Final Field Test of the respective load.

F. Any deficiencies or issues which may arise during Preliminary Field Tests, Preliminary Loading Test or Panelboard Final Field Test shall be remedied by the Contractor at no additional cost to the City.

G. Manufacturer’s Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the panelboard, check the panelboard installation before it is placed into operation and assist in the performance of Preliminary and Final Field Tests.

2. The Manufacturer’s representative shall provide panelboard Start-up services and Training of the Contractor and the City’s operations and maintenance staff in the care, operation, and maintenance of the panelboard in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

a. Minimum number of manufacturer's representative site visits for all panelboards:

Visit Type	Minimum Number of Visits	Number of Person(s)	Minimum Number of Days
Equipment Installation and Inspection	1	2	3
Field Tests	1	2	1
Acceptance Testing	1	2	1
Training	1	2	1

b. Additional trips or days that are required to achieve the proper installation, operation or training, such services shall be arranged for by the Contractor at no additional cost to the City.

c. The Engineer shall have the right to reallocate any unused time.

3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.

a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

b. The panelboard manufacturer's representative shall certify in writing to the Engineer that the panelboard has been installed, setup and tested properly in accordance with Contract requirements and is operating at optimum conditions and capacity.

4. The manufacturer representative shall also make any necessary adjustments and instruct the Site personnel in its operation and maintenance.

5. The service representative shall sign in and out with the Engineer on each day they are at the site.

6. A day shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. Panelboard Startup

1. Panelboard Startup shall comply with the requirements of Section 01 79 05 – Startup and Training and shall be considered completed when all the circuit loads on the panelboard completes their startup requirements.

B. Panelboard Training

1. The Contractor shall provide Training on the panelboard in compliance with Section 01 79 05 – Startup and Training
2. The Contractor shall submit for approval by the Engineer, lesson plans identifying in detail, the training to be conducted.
3. The Contractor shall coordinate training services with the City and the Engineer.
4. The Contractor shall schedule training at least forty-five (45) days prior to delivery of training subject to the approval of the Engineer and the City.
5. The training shall consist of both classroom and field instruction.
6. The purpose of field instruction shall be to reinforce topics covered in the classroom and to identify the location of all panelboard components.
7. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

C. The manufacturer's representative shall sign in and out at the office of the Resident representative on each day he is at the project.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SECTION 26 25 00 – LV METAL-ENCLOSED BUSWAY
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, furnish all materials and equipment required to provide metal-enclosed busway systems complete including all necessary fittings, hangers and accessories as shown and specified under this Section, the Specifications, and the Contract Drawings.

B. Coordinate busway connections with connected equipment and physical conditions to ensure compatibility of installation.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. 26 05 29 – Hangers and Supports for Electrical Systems

B. 26 05 48 – Vibration and Seismic Controls for Electrical Systems

C. 26 06 11 – Cable and Conduit Schedule

D. 26 08 11- General Electrical Testing

E. 26 23 23 – LV Switchgear

1.04 REFERENCES

A. The low voltage busway and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards of ANSI and NEMA:

1. NEMA BU.1 - Busways
2. ANSI/UL 857 - Standard for Busway and Associated Fittings
3. NEC - National Electrical Code

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Manufacturer shall have experience of producing substantially similar equipment to that specified and shall be able to provide documentation of at least five installations in satisfactory operation.

B. Busway manufacturer shall be ISO 9001 certified.

C. Component Supply and Compatibility:

1. Obtain all products included in this Section, regardless of component Supplier, from one metal-enclosed busway manufacturer.
2. All components shall be suitable for specified service conditions and shall be integrated into overall assembly by the Supplier.

D. Regulatory Requirements:

1. NEC Article 364, Busway.

1.07 SUBMITTALS

A. Shop Drawings: After performing field evaluation specified in Paragraph 3.1.A of this Section, prepare and submit the following:

1. Layout drawings showing busway routing with components identified and interface to connected equipment.
2. Bus duct Shop Drawing and related product data shall include all accessory items, including heater wattage, fittings, and supports.

B. Product Data: Submit the following:

1. Manufacturer’s technical information and components for busway proposed.

C. Field Quality Control Submittals: Submit report of field quality control activities, including results of field tests and reports of Supplier's visits to Site.

D. Qualifications Statements: Provide qualifications statements when requested by Engineer.

E. Certificate of Compliance: Seismic qualification certification from the manufacturer including mounting recommendations.

F. Bill of Materials.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling:

1. Deliver products to the Site to ensure uninterrupted progress of the Work.

2. Inspect products for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.

3. Notify Engineer of loss or damage to equipment or components. Replace loss and repair damage to new condition per manufacturer's recommendations.

4. Handle products in accordance with manufacturer's instructions and Section 01 65 00, Product Delivery Requirements.

B. Storage:

1. Store busway equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

2. Store materials for easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect equipment from corrosion and deterioration.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. One set of joint covers for each busway

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Busway and accessories shall be as manufactured by:

1. ABB,

2. Eaton,

3. Square D,

4. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. The busway shall be voltage and current ratings as indicated on the Contract Drawings.

B. The busway shall have a minimum of 6-cycle short-circuit rating of 200 kA RMS symmetrical for ratings.

C. Bus Construction:

1. One-hundred percent conductivity, bar-type, copper, with silver-plated joints insulated over entire length by fluidized flame retardant epoxy coating insulation with suitable insulators between bars and housing.

2. Bus shall be capable of carrying rated current continuously without exceeding temperature rise of 65 degrees C in a 40 degrees C ambient temperature.

3. Bus joints shall use single- or double-splice plates and be insulated with removable boots.

4. Ground bus shall be copper, 50 percent internal ground.

D. Bus Joints

1. Each busway section shall be furnished complete with joint hardware and covers. The busway joints shall be a single-bolt, non-rotating, removable bridge design. All bridge joints shall be furnished with torque-indicating double head joint bolts and Belleville washers. The bridge joint shall utilize a captive nut retainer on the opposite side of the torque-indicating bolt. The bridge joint design shall ensure proper installation without the use of a torque wrench, and provide visual indication that the joint has been tightened to the proper torque value. Each busway joint shall allow for a minimum length adjustment of +/- 0.5 inches. De-energization of busway shall not be required for safe testing of joint tightness.

E. Housing Construction

1. Housing shall be 11-gauge aluminum, bolted together with Type 316 stainless steel hardware. Busways located outdoors shall be suitable for the environment and shall be of weatherproof construction.

2. Busways shall have removable covers and access to bus joints for safe testing without de-energizing electrical system.

3. Busway sections shall be removable without disturbing adjacent sections or fittings of busway.

4. Housing finish shall include one coat, 1.5 to 2.0 mils dry film thickness, of baked-on epoxy powder paint (gray color: “ANSI 61”, with high gloss) applied electrostatically to pre-cleaned and phosphatized metal, on both inside and outside surfaces of housing. Coating shall have corrosion

resistance to 600 hours of five percent salt spray. Paint system for outdoor installations shall be resistant to degradation and chalking by ultraviolet radiation.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Test

1. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

2. The manufacturer shall provide three (3) certified copies of factory test reports.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Pre-submittal Field Evaluation: Provide field engineer from busway manufacturer to conduct field inspections before busway fabrication. Field inspection required under this paragraph is in addition to field quality control requirements specified in Article 3.3 of this Section. Manufacturer's field engineer shall ensure that each busway run shall be suitable for physical installation and that all fittings, special sections, and terminations required have been accounted for and are included.

B. Examine conditions under which the Work is to be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install busway runs as shown on the Drawings.

B. Securely support busway independently of equipment, except as recommended in manufacturer's standard, published data.

C. Install horizontal indoor runs suitable for hanging overhead by hangers at maximum intervals four feet on centers.

D. Install in conformance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents.

3.03 FIELD TESTING / QUALITY CONTROL

A. Site Tests:

1. Provide field testing and inspection of busway. After installation, inspect, adjust, and test each busway. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by factory-trained Supplier's representative. Through Contractor, Supplier's representative

shall inform field engineer when equipment has been correctly installed. Do not energize equipment without permission of the field engineer.

2. Perform the following tests and checks before energizing equipment:

   a. Verify proper installation and inspect all runs for entire length for physical and mechanical condition, anchorage, alignment and grounding.

   b. Check tightness of bolted connections and torque to manufacturer's requirements.

   c. Perform insulation resistance tests of each busway, phase-to-phase and phase-to-ground.

   d. Perform an overpotential test on each busway, phase-to-ground.

   e. Perform other tests and adjustments recommended by equipment manufacturer.

B. Manufacturer Services:

1. Factory-trained Supplier's representative shall inspect and test the system as specified in Paragraph 3.3.A of this Section. Supplier's representative shall inspect and test the Work in presence of Engineer and verify that equipment conforms to requirements.

2. Supplier's representative shall re-visit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.

3. Provide services of factory-trained Supplier's representative to correct defective Work within 72 hours of notification during the Contract correction period specified.

4. Replacement parts or equipment provided during the correction period shall be equal to or better in quality than original.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing low-voltage fuses. Low-Voltage Fuses shall be provided in accordance with the requirements of the Contract Drawings and Specifications.

B. Fuses shall be suitable for use with power circuits.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and other Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volts Class.

B. Reference Standards: Low-voltage fuses shall comply with the latest applicable provisions and recommendations of the following even if not specifically listed in this Section:

1. UL 248 - Low-Voltage Fuses.

2. NEMA FU1 - Low-Voltage Cartridge Fuses.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

1. Low-voltage fuses shall be designed, built and tested in accordance with UL 248.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's catalog cuts for the fuses proposed for use with specifications and other data required to demonstrate compliance with the specified requirements.

2. Time-current curves for the fuses proposed for use.

B. Reports

1. Field Test Reports shall be submitted.

2. Manufacturer's site visit report shall be submitted.

C. Operation and Maintenance Manual

1. Operation and Maintenance Manuals shall be submitted in accordance with this Section and the Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Fuses shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Spares

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare fuses in accordance with this Section and the Specifications.

2. The spare fuses shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

3. Spare fuses shall include at a minimum the following:

a. Ten (10) percent of each rating used.

b. Minimum of three of each rating.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Low-voltage fuses shall be as manufactured by:

1. Mersen Ferraz Shawmut, San Francisco, CA;

2. Littlefuse, Chicago, IL;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General:

1. Fuses shall be compatible with the system operating voltage shown on the Contract Drawings.

2. Low-voltage fuse ampere ratings shall be as shown on the Contract Drawings.

B. Low-voltage Fuses:

1. Low-voltage fuses shall be current limiting, time delay type. Low-voltage fuses shall have a 200,000 RMS symmetrical ampere interrupting rating.

2. Low-voltage fuses with current ratings up to 600 amperes shall be UL class RK1.

3. Low-voltage fuses with current ratings greater than 600 amperes shall be UL class L.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Fuses shall be installed within equipment in accordance with the manufacturer's recommendations and industry standards.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing enclosed controllers. Enclosed controllers shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems

D. Section 26 08 11 - General Electrical Testing

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

B. Reference Standards

1.	NEC	-	National Electrical Code.
2.	UL 98	-	Enclosed and Dead-Front Switches
3.	UL 508	-	Industrial Control Equipment
4.	UL 489	-	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
5.	NEMA KS-1	-	Heavy Duty and Dead-Front Enclosed Switches
6.	NEMA ICS	-	Industrial Control and Systems General Requirements
7.	NEMA ICS 2	-	Industrial Control and Systems, Controllers, Contactors and Overload Relays rated 600V.
8.	NEMA ICS 5	-	Industrial Control and Systems Control-Circuit and Pilot Devices
9.	NEMA ICS 6	-	Industrial Control and Systems Enclosures

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Unless otherwise shown on the Contract Drawings, or directed by the standards and codes referenced under this Section, the Contractor shall provide for each low-voltage motor or other power device, complete equipment for starting, stopping and control.

B. The starting, stopping and control equipment shall be provided with features of protection, current limitation, functioning and be complete with all accessories, appurtenances and supporting structures.

C. Control equipment shall be UL listed and properly designed with relation to the characteristics of operation of the motor and or device controlled.

D. Each motor shall be provided with control equipment consisting of apparatus as follows:

1. Motors of 1/4 HP or less may, in the absence of other requirements, be controlled by a manual motor starter having thermal overload protection at all times.
2. Motors larger than 1/4 HP shall be controlled by a magnetic motor starter.
3. For wound rotor motors of all horsepower ratings, the primary and secondary shall be controlled by a magnetic motor starter or as shown on the Contract Drawings.
4. Multiple speed squirrel cage motors, shall be controlled by a magnetic motor starter. The magnetic motor starter shall provide adequate protection of the motor at each speed. A line establishing contactor shall be provided for each motor speed.

E. Each motor shall include overload protection based on latest standards.

1.07 SUBMITTALS

A. Shop Drawings

1. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:
   a. Manufacturer's catalog cuts, technical information, and enclosure details for the enclosed controllers.

B. Operations and Maintenance Manuals

1. Operations and Maintenance Manuals
   a. Operation and Maintenance Manuals shall be submitted in accordance with the Specifications.

C. Bill of Materials

1.08 DELIVERY, STORAGE, AND HANDLING

A. Enclosed controllers shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer's instructions.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the enclosed controllers in accordance with this Section and the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. The following spare parts shall be furnished:

1. One (1) set of contact tips, shunts and coils shall be provided for each 6 or less of each size motor starter.

2. One (1) auxiliary contact unit or one set of auxiliary contact tips shall be provided for each 6 or less motor starter.
3. Two (2) sets of arc chutes shall be provided for each type and rating of magnetic contactor.
4. One (1) timing relay shall be provided of each type installed as part of control equipment installation.
5. One (1) complete auxiliary relay shall be provided of each type installed as part of control equipment installation.
6. One (1) control transformer shall be provided of each rating and type installed as part of control equipment installation.
7. Two (2) complete sets of fuse replacements shall be provided of each rating and type installed as part of control equipment installation.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switching devices shall be as manufactured by:
1. General Electric Company, Stamford, CT
2. Siemens, Washington, DC
3. Or approved equal.

B. Magnetic motor starters shall be as manufactured by:
1. General Electric Company, Stamford, CT
2. Siemens, Washington, DC
3. Or approved equal

C. Manual motor starters shall be as manufactured by:
1. General Electric Company, Stamford, CT
2. Siemens, Washington, DC
3. Or approved equal

D. Control stations shall be as manufactured by:
1. General Electric Company, Stamford, CT
2. Siemens, Washington, DC
3. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Switching Devices

1. Switching devices shall be low-voltage devices provided in accordance with the details shown on the Contract Drawings. The switching devices required under this Section shall be the disconnect switch and circuit breaker types.

2. Switching devices shall be enclosed in NEMA type enclosures in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

3. Switching device line and load terminals shall be provided with shields to prevent accidental contact with them. In addition, instrument probe holes shall be provided within the shields to permit investigation of the state of the terminals, by authorized personnel and approved procedures.

a. Disconnect switch type switching devices shall be in accordance with the following:

1) Switches shall be heavy duty type with number of poles, voltage and current ratings as shown on the Contract Drawings.

2) Switches shall be capable of interrupting the full rated current at full rated voltage.

3) Switch enclosure shall be provided with a viewing window through which it shall be permissible to observe the state of the main contacts and surge protective devices when provided.

4) Disconnect switches shall be complete with fuses, surge protective devices and remote operation.

5) Switches shall be the quick make and quick break type covered with an arc resisting barrier. The switch shall be provided with provision for locking in either open or closed position. The ratings shall be as follows:

Switch Rating in Amperes	Motor Horsepower	
	208-240 Volts	480Volts
60	Over 5 to 15	Over 5 to 30
100	Over 15 to 25	Over 30 to 60
200	Over 30 to 50	Over 60 to 125
400	Over 50 to 75	Over 125 to 200

b. Circuit breaker type switching devices shall be in accordance with the following:

1) Circuit breakers shall be the molded case type with number of poles, voltage and current ratings as shown on the Contract Drawings.

2) Breakers shall be manually or remotely operated thermal magnetic or solid-state type, including inverse-time overload and instantaneous short-circuit protection. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of arc chutes.

3) Breakers shall have 100 amps frames as a minimum. Overload protection shall be provided on all poles, with trip settings as shown on the Contract Drawings.

4) Breakers with frame sizes 225 amps or larger shall have interchangeable trip units and adjustable magnetic trip elements.

5) Breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position.

6) Breaker enclosures shall be equipped with an external lockable handle with provision for locking in the closed or open position.

7) Breakers shall be provided with electronic trip units. Electronic trip units shall include long time, short time, instantaneous and ground fault settings as minimum.

8) Breakers shall be provided with zone interlocking features, shunt trips, provisions for annunciation of status and auxiliary devices.

B. Motor Starters

1. Magnetic

1) Magnetic motor starters shall be provided complete with fused control power transformer, pilot devices, auxiliary contacts and accessories as shown on the Contract Drawings or stated in the Detailed Specifications.

2) Magnetic motor starters shall be enclosed in NEMA type enclosures in accordance with the requirements specified under this Section. The starter shall be combination type.

The enclosure shall be equipped with an external operable, pad lockable handle, arranged so that it is impossible to open the door unless the breaker is open.

3) The starter shall be magnetic coil operated and shall include a magnetic or solid state motor circuit protector with trip unit range adjustable from 700 to 1300 percent of full load.

4) The combination starters shall be suitable for interrupting the available low-voltage short circuit infeed at the line terminals of the enclosure.

5) Magnetic contactors shall be 3 pole, single throw, 60 Hz with auxiliary contacts for under-voltage protection. Contactors shall be mounted upon steel bases with insulated mountings or upon bases of insulating material. Contactors shall be provided with necessary barriers and arc chutes.

6) Contactors shall be NEMA rated as follows:

NEMA Size of Contactor	Motor Horsepower	
	208-240 Volts	480Volts
1	1/4 to 7-1/2	1/4 to 10
2	Over 7-1/2 to 10	Over 10 to 25
3	Over 15 to 25	Over 25 to 50
4	Over 30 to 40	Over 50 to 100
5	Over 70 to 75	Over 100 to 200

7) Contactors in Sizes 1 through 4 shall have double break, silver to silver main contacts. Contactors in Size 5 shall have silver plated tips which close with rolling action and which have self-aligning and self-cleaning features. Auxiliary and interlocking contacts for all sizes shall be of the silver button type. All contact tips shall be easily renewable. Flexible shunts shall be tinned copper braid or tinned extra flexible copper cable.

8) Overload relays shall be of the ambient temperature compensated bi-metallic or solid-state type with interchangeable sensors and manual reset feature. Relay shall include a normally open auxiliary contact for remote alarm purposes. Sensors for overload relays shall be selected to match full load currents of the motors to allow motor operation at maximum safe loads without damage to equipment. Full load current data shall be obtained from nameplates of motors actually installed.

9) Pilot devices shall be heavy duty type, rated 10 amps continuous. Pushbuttons, selector switches, indicating lights, and other devices shall be located on the starter enclosure. Indicating lights shall be push-to-test, LED, transformer type with 12-volt secondaries.

10) Relays shall be standard, latching type and pneumatic or solid-state time delay type. Relays shall be provided with contacts rated 10 amps with number as required.

11) Special overload protection shall be provided where definite purpose motors cannot be protected by standard thermal overload relay applications.

2. Manual

a. Manual motor starters shall be provided complete with pilot devices as shown on the Contract Drawings.

b. Manual motor starters shall be enclosed in NEMA type enclosures in accordance with the requirements specified under this Section.

c. Manual motor starters shall be toggle operated, NEMA horsepower rated, single phase type with thermal overload protection unless shown otherwise on the Contract Drawings. Pilot devices when required shall be in accordance with the requirements specified under this Section.

d. Where shown on the Contract Drawings, manual motor starters shall be low-voltage, three phase type without overload protection for use as manual starting disconnect switches. The switches shall be NEMA size 0 or 1 horsepower rated, as required for the application intended.

3. Control Stations

a. Control Stations shall be provided in accordance with the details on the Contract Drawings.

b. Control Stations shall be enclosed in NEMA type enclosures in accordance with the requirements specified under this Section.

c. Control stations shall be industrial, heavy duty, oil tight construction with clearly marked legend plates. Stations shall have operating devices as shown on the Contract Drawings.

d. Contact ratings shall be 10 amps minimum. All indicating lights shall be LED, transformer type, lens color shall be as shown on the Contract Drawings.

4. Enclosures

a. Enclosures shall be provided for the enclosed controllers.

b. Enclosures located indoors in dry, dusty areas shall be gasketed and shall be constructed of 14-gauge sheet steel.

c. Cabinet type enclosures shall include hinged and gasketed front doors.

d. Enclosures shall be provided in accordance with NEMA requirements as required for the area classifications indicated on the Contract Drawings.

1) For dry, dusty locations, enclosures shall meet NEMA 12 requirements.

2) For wet and corrosive locations, enclosures shall meet NEMA 4X requirements. NEMA 4X enclosures shall be fabricated from 316 stainless steel.

3) Enclosures within hazardous locations shall meet Class 1, Division 1, Group D requirements. Hazardous enclosures shall be fabricated from cast metal.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Equipment shall be mounted so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Equipment shall be securely fastened to walls or other surfaces on which they are mounted.

C. Independent supports shall be provided where no wall or other surface exists.

D. Enclosed controllers shall be installed in conformance with the NYCEC.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Variable-Frequency Motor Controllers known as Variable Frequency Drives (VFD/s). VFDs shall be provided in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

B. The VFDs required under this Section shall be the low-voltage, voltage source pulse -width modulated inverter types. The VFDs shall include full bypass capability when shown on the Contract Drawings.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 53 – Identification for Electrical Systems

C. Section 26 05 91 – Low-Voltage Electric Motors

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volt and within the 600 V Class

B. Reference Standards. VFD shall comply with the latest applicable provisions and recommendations of the following:

1.	NEC	-	National Electrical Code.
2.	NEMA ICS 2	-	Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 volts.
3.	NEMA ICS 7	-	Adjustable Speed Drive Systems.
4.	NEMA MG-1	-	Motors and Generators.
5.	NETA ATS	-	NETA Acceptance Testing Specification.
6.	NIST	-	National Institute of Standards and Technology.
7.	IEEE 519	-	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
8.	ANSI/UL 508	-	Industrial Control Equipment.
9.	UL 489	-	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

1.05 DESCRIPTION

A. VFD General

1. Each VFD unit shall consist of an adjustable frequency controller with contactor bypass and associated controls for continuous speed adjustment and protection of the driven equipment.

2. The adjustable frequency controller shall be a microprocessor-based, pulse-width modulated design, suitable for operation on a low-voltage, 3 phase, 60 Hz supply.

3. The controller shall consist of

a. a power factor /harmonic filter unit (if required)

b. 18 pulse, minimum, diode-bridge converter fed by rectifier-grade phase-shifting transformer.

c. a fixed DC bus section

d. and an IGBT based power transistor inverter output section.

4. The controller shall produce an adjustable AC voltage/frequency output to vary the speed of the driven equipment and maintain the drive motor Volts/Hz rating.

1.06 QUALITY ASSURANCE

A. VFDs shall be designed, built and tested in accordance with the latest applicable editions of ANSI/IEEE, NEMA, and UL.

B. The VFD shall be UL listed.

C. The VFD manufacturer shall have ten (10) years' experience in the design and be regularly engaged in manufacturing and servicing equipment for installations of the type and size specified under this Section.

D. Each VFD shall be totally compatible with the driven equipment and motors. The VFD shall be matched to the driven equipment specific load requirements for each system specified in this Section or as shown on the Contract Drawings.

E. Output speed control of the controlled motor shall be continuous throughout speed range of 2 to 60 Hertz under variable torque load or constant torque load as specified for the driven equipment.

F. Operation of the variable frequency drive shall not over stress the driven motor insulation system.

G. Each and multiple VFD/s installation/s shall meet the requirements in IEEE 519 for individual and total harmonic voltage and current distortion on both the utility and emergency generator.

H. In order to centralize responsibility and to ensure that all equipment is properly coordinated, the VFDs specified under this Section shall be obtained from the driven equipment suppliers.

I. All VFDs that comprise a given system shall be similarly equipped. Similar components of each system shall be the product of a single manufacturer.

J. All materials, equipment and parts comprising the each VFD shall be new, of current manufacture and of the highest grade. All components shall be covered by the manufacturer's standard warranty on new VFDs.

K. The VFD manufacturer shall have complete parts and service facilities and a factory-trained serviceman, located within a hundred miles of the project site, available on a 24-hour basis. Services shall be readily available so to avoid long periods of interruption or require extensive spare parts inventory.

L. Unless otherwise authorized by the Engineer, the manufacturer's service representative shall be direct employee of the equipment manufacturer, with at least five (5) years of experience in the installation, testing and startup of equipment specified herein.

M. Manufacturer's sales and marketing representatives shall not be accepted as manufacturer's service representative.

N. The VFD manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests.

O. Calibration of testing apparatus shall be within one year.

P. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the NIST.

Q. Field Tests:

1. VFDs shall be field tested. Field testing shall be performed in accordance with the requirements specified under this Section.

2. Retain the services of the VFD manufacturer for field service. Field service shall be in accordance with the requirements specified under this Section.

3. Retain the service of an independent testing firm who shall perform field acceptance testing of the VFD. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA.

4. Acceptance testing shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's technical information which shall include:
    a. Dimensional information and construction details of enclosures. Enclosure details shall consist of exterior and interior front door with nameplate legends, interior door front and rear views and terminal block layout.
    b. Three-line power and control schematic diagrams.
    c. Technical specifications.
    d. Catalog cuts.
    e. Wiring diagrams showing the interconnection of conductors to remote devices with terminal assignments.
    f. Harmonic analysis which shall include all voltage and current harmonics up to the 49^{th}.
3. Description of shop and field-testing methods and procedures, and apparatus with calibration dates shall be submitted.
4. Testing methods and procedures shall be submitted at least 90 days in advance prior to conformation of witness testing dates and actual testing.
5. Qualifications of proposed service firm who will perform the service and maintenance agreement. Five (5) recent references with phone numbers shall be submitted.

B. Certificates of Compliance

1. Certification letters from the VFD and motor manufacturers that the approved driven equipment has been reviewed and that the VFDs and motors are compatible and shall be provided in accordance with the requirements specified.

C. Reports

1. Manufacturer’s written determination as to whether reforming of DC bus capacitors is required before the commencement of Field Tests.
2. Shop test and field test reports shall be submitted.
3. Manufacturer's site visit report shall be submitted.

D. Software

1. Software shall be submitted and provided to permit the Engineer or other selected authorized personnel:
    a. To set or modify VFD parameters.
    b. Perform analysis of VFD operation.

c. View and analyze VFD faults.

E. Operation and Maintenance Manuals

1. Operation and Maintenance Manuals shall be submitted in accordance with this Section and the Specifications.

F. Bill of Materials

1.08 DELIVERY, STORAGE, AND HANDLING

A. VFDs shall be delivered, stored and handled in accordance with this Section and the Specifications, the manufacturer's instructions and the following:

1. VFD equipment shall be inspected for shipping damage or loose parts when received.

2. Evidence of water which may have entered equipment during transit shall be checked for.

3. VFD equipment shall be stored in a clean, dry location in which a uniform temperature is maintained. Equipment shall be protected with coverings and air circulation shall be maintained.

4. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the VFD in accordance with this Section and the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished and shall include one set for every four drives installed per horsepower rating. Each spare part set shall consist of the manufacturer's recommended spare parts inventory and shall include at a minimum the following:

1. One (1) set of transistor and diode modules with accessories.

2. One (1) power supply module

3. One (1) set of fans

4. One (1) set of power fuses of each size and type used.

5. Two (2) sets of control power fuses of each type and size used.

6. Two (2) per ten of pilot lights of each type used.

D. A rugged portable microprocessor based viewer shall be provided to run software provided to set or modify VFD parameters, perform analysis of VFD operation and view and analyze VFD faults.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. VFDs shall be as manufactured by:

1. Siemens-Robicon, Alpharetta, GA;
2. Schneider Electric, Andover, MA;
3. ABB, New Berlin, Wisconsin;
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Enclosure

1. Each VFD shall be provided with a free standing, dead-front, front access, grounded, NEMA 12, filtered and gasketed enclosure. Each enclosure shall be suitable for mounting all components required of a given unit.
2. Each enclosure shall provide adequate cooling for the components within and shall include positive ventilation.
3. Each enclosure shall include a circuit breaker disconnect switch. The switch handle shall be suitable for padlocking and shall be through-the-door type. Operation of the switch shall remove the service supply from all internal components. Power devices shall be suitable for the interrupting capacity shown on the Contract Drawings. Include current limiting semi-conductor fuses where required for protection of solid-state components.
4. Each enclosure door shall include an operator interface for access to controller's digital keypad and display.
5. The enclosure shall have identifying nameplates in accordance with the requirements of Section 26 05 53 - Identification for Electrical Systems.
6. Each enclosure shall be equipped with phenolic type terminal blocks suitably labeled for all internal and remote wiring requirements plus 20 percent spares.

B. Adjustable Frequency Controller

1. General

a. The adjustable frequency controller shall be microprocessor-based, pulse width modulated design, suitable for operation on a low-voltage, 3 phase, 60 Hz supply.

b. The controller shall produce an adjustable AC voltage/frequency output to vary the speed of the driven equipment and maintain the drive motor V/Hz rating.

c. The controller shall consist of

1) A power factor /harmonic filter unit (if required)

2) 18 pulse, minimum, diode-bridge converter fed by rectifier-grade phase-shifting transformer.

3) A fixed DC bus section

4) A 3 percent DC bus reactor or input line reactor.

5) An IGBT based power transistor inverter output section.

d. The controllers' solid state converter input section switching devices shall have a 1600-volt PIV rating.

e. The controller shall have an overload rating of 110 percent variable torque, 150 percent constant torque for one minute.

f. RMS harmonic content of output current shall be less than 5 percent of fundamental current.

g. Controller shall be able to withstand output terminal line-to-line short circuits without component failure.

2. Operating Criteria

a. The controller's operating criteria shall be in accordance with the following:

1) Ambient temperature range shall be 0 degrees C to 40 degrees C.

2) Operational humidity shall be up to 90 percent non-condensing.

3) Altitude shall be below 3,300 feet above sea level.

4) Nominal input voltage variation shall range from plus 10 percent to minus 10 percent.

5) The controller shall include an undervoltage feature to permit trip-free operation down to 35 percent undervoltage.

6) Nominal frequency shall be 60 Hertz plus or minus 3 Hz.

7) Input power factor shall be 95 percent displacement power factor at all operating speeds.

8) Efficiency shall be a minimum of 96 percent at full speed and full load.

9) Losses in the efficiency calculations shall include those of the input transformer, harmonic filter, and power factor correction if applicable, convertor, output filter if applicable, auxiliary controls, internal boards and cooling equipment.

3. Features

a. The controller shall have features in accordance with the following:

1) Digital keypad and display module shall provide parameter setting, adjustments and monitoring of control functions and faults. Display messages shall be in English.

2) Serial communication port shall allow connecting to a programmable logic controller interface.

3) Independent acceleration/deceleration rates shall provide 2 to 600 seconds minimum. When called to stop, the motor shall decelerate to minimum speed before stopping.

4) Power loss feature shall allow ride through capability.

5) Time delay automatic restart shall allow restart after controller fault conditions with programmable attempts.

6) Coasting motor restart shall permit the controller to restart into a coasting motor without damage or tripping.

7) The coasting motor restart feature shall allow switching from bypass mode to VFD mode while operating without shutdown.

8) Control inputs and outputs shall be isolated.

4. Protection and Logging of faults

a. The controller shall have protective functions in accordance with the following:

1) Input line surge protective device shall provide transient protection.

2) Electronic over-current trip shall provide instantaneous and inverse time overload protection.

3) Over-temperature trip shall provide temperature protection.

4) Current limit trip shall provide current protection.

5) Input line over and under voltage trip shall provide voltage protection.

6) Ground fault trip shall provide ground protection.

b. The controller shall have a built-in fault log in accordance with the following:

1) All faults shall be retained indefinitely in the log.

2) The date and time of each fault shall be part of the information describing the fault.

3) It shall be possible to download the complete fault log into a CSV file for off controller analysis.

C. Output Filter

1. General

a. An output filter shall be provided to prevent overstressing the motor insulation system. An output filter shall be included for each VFD, whenever the cable length between the motor and VFD exceeds the following based upon the noted switching frequencies.

1) 1 KHZ switching frequency, 200 feet cable length.

2) 3 KHZ switching frequency, 175 feet cable length.

3) 12 KHZ switching frequency, 100 feet cable length.

b. Output filters shall be provided in all other cases, based upon the recommendations of the VFD and motor manufacturer's, whenever the actual voltage peaks at the motor terminals exceed the NEMA-MG1 limits.

2. Filter Design:

a. The filter shall be three phase, low-voltage class motor-protecting type consisting of suitable values of inductance, capacitance, and resistance to form a damped, low pass filter.

b. The filter shall be a low-loss type specifically designed to reduce the voltage wave form dV/dT. The filter shall allow cable lengths at minimum exceeding the actual application distances with a waveform resulting in voltage spikes at the motor terminal which are within the NEMA-MG1-Part 31 voltage stress levels.

c. The filter shall be suitable for mounting within the VFD enclosure.

D. Bypass Contactors

1. General

a. Each VFD shall be provided with contactor bypass capability. The bypass equipment shall be suitable for mounting within the VFD enclosure.

b. The bypass configuration shall consist of output and bypass contactors, as well as a line side isolation contactor.

c. The bypass arrangement shall permit full speed operation of the driven equipment while maintaining complete isolation of the adjustable frequency controller.

2. Contactors

a. Contactors shall be single speed full voltage, electrically operated, 600 volts, 3 pole, industrial duty with ampere ratings as required for the driven equipment.

b. Contactors shall have removable main contacts, 120-volt magnetic coil and interlocking contacts. Interlocking contacts shall be arranged to prevent the output and bypass contactors from being closed at the same time.

c. The bypass contactor shall include a VFD/bypass selector switch and associated controls for manual selection of operating mode. The bypass contactor shall also include a transfer timer. The timer shall provide an adjustable off delay whenever switching from VFD to bypass.

3. Overload Relays

a. Overload relays shall be provided to monitor each phase and neutral of the bypass circuit of each VFD.

b. Overload relays shall be solid-state, multichannel, multifunction type for use with or without current sensors.

c. Overload relays shall include ambient temperature compensation and shall be sized for the full load amperes and service factor of the actual motors furnished.

d. Overload relays shall have the capability to manually reset its functions and shall include a normally open and normally closed auxiliary contacts for alarm indication.

E. Controls

1. General

a. Each VFD control system shall be equipped with all control and pilot devices and other components required for a complete functional system.

b. Each VFD control shall be powered from a suitably sized and protected control power transformer.

c. Each VFD control shall include status indicators, controller and system fault condition displays and operating controls.

d. Status indicators and operating controls associated with the drives control shall be installed on the front door of the enclosure.

e. The control arrangement shall be such that the VFD internal electronic supply voltage is isolated from all field wiring.

2. Control and Pilot Devices:

a. Relays shall be standard, latching type and solid-state time delay type.

b. Relays shall be provided with contacts rated ten (10) amps with number as required.

c. Pilot devices shall be heavy duty type, rated ten (10) amps continuous.

d. Indicating lights shall be push-to-test transformer type with 12-volts secondaries.

F. Auxiliary Features:

1. Each VFD shall be provided with the following auxiliary features.

a. Status indicators shall include separate pilot lights for indication of

1) Motor run –Red.

2) Control power on - White.

3) Bypass mode - Blue.

b. Shutdown and alarm indicators shall include separate pilot lights.

1) Amber for each of the shutdown and alarm condition.

c. Shutdown indication circuitry shall be arranged such that when activated, the indicator will require manual reset.

d. Contact outputs shall include separate dry contacts for remote indication of motor run, each shutdown condition and controller faults.

e. Speed output shall include a 4-20 MA signal for remote indication of motor speed.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Finishes

1. All metal surfaces of the VFD shall be thoroughly cleaned and given one coat of zinc chromate primer.

2. All interior surfaces shall then be given one shop finishing coat of a nitro-cellulose lacquer enamel.

3. All exterior surfaces shall be given three coats of the same lacquer. The color of the exterior finishing coats shall be light gray ANSI No. 61.

4. All printed circuit boards shall be coated with a conformal coating to provide protection for all components.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed at the VFD manufacturer's plant prior to shipment.

2. Shop test shall demonstrate that the equipment tested conforms to the requirements specified.

3. Manufacturers standard factory tests shall be performed on each VFD and shall in addition include:

a. Operating the VFD with a motor of ratings similar to the driven equipment motor through all of the speed and load ranges in a heated environment for a minimum of two hours.

b. Simulation of each control signal and each alarm function to verify proper and correct drive action.

4. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests

3. For the Witnessed Shop Test the Contractor shall perform all of the Certified Tests in the presence of the witnesses.

4. The VFD shall be shipped to the driven equipment manufacturer's plant for witnessed system shop performance testing. The system shop performance testing shall be in addition to the shop test specified under this section.

5. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

6. The VFD shall not be shipped before the approval of the Shop Test Report

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

Not Used

3.02 INSTALLATION

A. VFD equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. VFD equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. VFD equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

D. Steel channels shall be provided for support of equipment. Equipment shall be secured to mounting surface with anchor bolts of sufficient size and number to secure equipment.

E. Install nameplates for identification of equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, VFD shall be field tested for operation and conformance. The Contractor shall perform field tests in accordance with this Section and Specifications.

B. VFD testing shall be performed by the manufacturer's representative, prior to energizing equipment.

C. Equipment shall not be energized without the permission of the Engineer.

D. The testing shall be in accordance with the recommendations of the manufacturer's representative and industry standards and shall consist at a minimum of the following:

1. Manufacturer’s determination of whether the reforming of DC bus capacitors is required,
2. Device settings and drive adjustments shall be verified.
3. Mechanical and electrical interlocks shall be inspected, and controls shall be checked for proper operation.
4. Each drive shall be tested through the specified speed ranges and loads for a minimum of two (2) hours.
5. Each drive shall be tested by using the actual control signal for remote and local operation.
6. Each drive alarm function shall be tested.
7. Tests to verify the Harmonic analysis submitted. Test shall be conducted at the input to the drive and shall be conducted with and without the VFD operating.

E. Manufacturer’s Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the variable frequency motor controllers, check the variable frequency motor controllers installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the variable frequency motor controllers.

2. The Contractor shall provide equipment start-up services and training in accordance with this Section, the Specifications, and the Contract Drawings and the following requirements:

   a. Minimum number of manufacturer's representative site visits:

Visit Type	Minimum Number of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation and Inspection	1	3	5
Field Tests	1	3	5
Acceptance Testing	1	2	3
Training	1	2	2

3. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

4. The Engineer shall have the right to reallocate any unused person-days.

5. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

6. The service representative shall sign in and out with the Engineer on each day they are at the site. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for designing and providing Solar Energy Electrical Power Generation System (Solar System). Solar System shall be designed and provided in accordance with the requirements specified under this Section and the Contract Drawings.

B. The Solar System shall be a complete system. This Section specifies the design, furnishing, installation, connection, testing, and commissioning of the Solar System.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 78 25 – Operation and Maintenance Manuals

B. Section 03 41 00 – Precast Structural Concrete

C. Section 05 12 00 – Structural Steel Framing

D. Section 26 05 11 – General Electrical Requirements

E. Section 26 05 20 – Low-Voltage Wires, Cables and Accessories

F. Section 26 05 27 - Grounding

G. Section 26 05 29 – Hangers and Supports for Electrical Systems

H. Section 26 05 33 – Raceways and Boxes for Electrical Systems

I. Section 26 05 53 – Identification for Electrical Systems

J. Section 26 28 13 – Low-Voltage Fuses

K. Section 26 29 13 - Enclosed Controllers

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Solar equipment structural system refers to the sub-framing, solar panel support racking, and connections to be fastened to the stainless-steel support stubs. To be designed by Contractor.

B. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 VAC and within the 600 V Class.

C. Reference Standards

1. NEC - National Electrical Code

2. NFPA 70E - Standard for Electrical Safety in the Workplace

3.	UL 1699 -	Standard for Arc-Fault Circuit-Interrupters
4.	UL 1699B -	Standard for Photovoltaic (PV) DC Arc-Fault Circuit Protection
5.	UL 1703 -	Standard for Flat-Plate Photovoltaic Modules and Panels
6.	UL 1741 -	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
7.	UL 2703 -	Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels
8.	UL 4703 -	Standard for Photovoltaic Wire
9.	IEEE 519 -	Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
10.	IEEE P929-	Recommended Practice for Utility Interface of Photovoltaic Systems
11.	IEEE 1262-	Recommended Practice for Qualifications of Photovoltaic Modules, Performance, and Reliability
12.	IEEE 1526-	Recommended Practice for Testing the Performance of Stand-Alone Photovoltaic Systems
13.	IEEE 1547-	Standard for Interconnecting Distributed Resources with Electric Power Systems
14.	ASTM E903 -	Standard Test Method for Solar Absorbance, Reflectance and Transmittance of Materials Using Integrating Spheres
15.	IEC 62852-	UV Exposure for connectors/cables
16.	IEC 62790-	UV exposure for junction boxes
17.	IEC 61215 and IEC 61646 -	Design Qualification and Type Approval for Crystalline Silicon and Thin-Film PV Modules
18.	IEC 62093-	Balance-of-System components for Photovoltaic Systems - Design Qualification Natural Environments
19.	IEC 62446-	Grid connected Photovoltaic Systems - Minimum Requirements for Systems Documentation, Commissioning Tests, and Inspection

20.	NIST	-	National Institute of Standards and Technology
21.	29 OSHA 1910	-	Occupational Safety and Health Standards
22.	NYSBC	-	2020 Building Code of New York State
23.	ASCE 7-16	-	Minimum Design Loads and Associated Criteria for Buildings and Other Structures

1.05 DESCRIPTION

A. System Description

1. The packaged solar equipment shall consist of PV panels, inverter(s), mounting, racking, Data Acquisition System (DAS), electrical connection, conduit, energy meter, safety equipment and miscellaneous equipment required for a complete installation of the equipment into the facility according to the Contract Drawings and as specified herein.

2. The Contractor shall integrate the packaged solar equipment into a singular structural assembly and shall ensure compatibility of each component such that the overall system operates optimally. The PV Vendor's equipment shall not extend beyond the boundaries designated for packaged solar equipment in accordance with the Contract Drawings, apart from cable and conduit required to provide a complete and functioning system.

3. The Contractor shall coordinate with the PV Vendor on necessary electrical connections required to deliver a complete and functioning system. All roof penetrations will be by the Contractor and coordinated with the precast roof slab manufacturer

B. Photovoltaic (PV) Collectors

1. Alternating-Current (AC) Module (Alternating-Current Photovoltaic Module): A complete, environmentally protected unit consisting of solar cells, optics, and other components, exclusive of tracker, designed to generate AC power when exposed to sunlight.

2. Array: A mechanical integrated assembly of modules or panels fastened to a support racking supported by the solar equipment structural system, and other components, as required, to form a direct-current power-producing unit.

3. Inverter: Equipment that is used to change voltage level or waveform, or both, of electrical energy. Commonly, an inverter (also known as a power conditioning unit (PCU) or power conversion system (PCS) is a device that changes DC input to an AC output.

4. Inverter Output Circuit: Conductors between the Inverter and an AC panelboard for stand-alone systems
5. Panel: A collection of modules mechanically fastened together, wired, and designed to provide a field-installable unit.
6. Photovoltaic Output Circuit: Circuit conductors between the photovoltaic source circuits and the inverter.
7. Solar Cell: The basic photovoltaic device that generates electricity when exposed to sunlight.
8. Maximum Power Point Tracking (MPPT): An electronic DC to DC converter that optimizes the match between the solar array (PV panels) and Utility Grid.
9. Combiner Box: A junction box that is used to combine multiple string of panels to common bus and provide single DC output.

C. The Contractor shall provide PV photovoltaic panels that meet or exceed the peak power output (kilowatt hours per year) as simulated by Helioscope, including accounting for shading of the surrounding structures. Exhibit A provides a list of assumptions to be used in the simulation, and in general requirements are:

1. Electrical Building:
   a. 7.99kW DC array
   b. 9.244 MWh annual production
2. If the Helioscope software is unavailable, an alternative industry standard shall be used, as approved by the Engineer.
3. To optimize energy output, the packaged solar equipment shall include panel optimization technology that may include but not limited to a maximum power point tracking (MPPT) scheme, and DC/DC converter optimizers.
4. All features necessary for satisfactory operation and functioning of packaged solar equipment shall be provided, whether or not they are described in these Specifications.
5. Solar equipment structural systems shall be designed to support PV photovoltaic panels and are permanently fastened to stainless-steel stub supports as specified within Contract Drawings. Assembly reactions are not to exceed maximum values outlined in the Contract Drawings. Framing shall be oriented to meet installation dimensions, orientation, and clearances as specified in the Contract Drawings and herein.

6. The Contractor shall not damage roofing, nor shall PV photovoltaic panels be attached to the standing seam metal roofing. All attachments of the PV photovoltaic panels shall be permanently fastened to the solar equipment structural systems, which shall be permanently fastened to the stainless-steel stub supports as shown on Contract Drawings.

7. Provide for thermal movement over an ambient temperature range of one hundred twenty degrees Fahrenheit (120°F) and a surface temperature of one hundred eighty degrees Fahrenheit (180°F).

8. The conduit penetration through the roof shall be localized and confined to a single location. PV Vendor shall coordinate this conduit penetration with the Contractor and the Roofing Contractor to ensure Contractor's unit responsibility for water-tightness of installation. The Contractor is too coordinate with precast roof slab manufacturer for incorporated openings as indicated on Contract Drawings and Specification Section 03 41 00 – Precast Structural Concrete.

9. The Contractor shall provide 120V electrical service for use by the PV Vendor to power its continuously operating power meter, Data Acquisition Systems, and other equipment and instrumentation required by the PV Vendor to provide a complete and fully functioning system.

10. Installed system shall meet NEC and all State and local codes, approved and listed to meet the following: New York State Fire Code, and New York State Building Code. Reflective warning signs shall be included per NEC 690.31(G)(3) and (4).

11. The packaged solar equipment shall be coordinated with and approved by Electric Utility. If required by Electric Utility, the installed system shall include additional equipment including but not limited to an anti-islanding device, a DNP3-enabled communications relay, network protection micro-processor relay and associated cabling, and/or conduit and cable between the communications and protective equipment.

12. All additional support system components required for support, transition of materials, items, and component systems associated with the packaged solar equipment Work shall be at no additional expense to DEP.

13. Equipment suppliers shall be consulted for proper installation and accessory information.

D. Permits and Fees

1. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses

necessary to carry out this Work and pay all fees therefor. The Contractor shall arrange for inspection and tests of any or all parts of the Work if required by authorities and pay all charges for same. The Contractor shall pay all costs for, and furnish to DEP before final billing, all certificates necessary as evidence that the Work installed conforms with all regulations where they apply to this Work.

1.06 QUALITY ASSURANCE

A. The requirements shown on the Contract Drawings are shown to convey minimum requirements of the Solar System. The Contractor shall obtain the services of a Solar System designer and installer regularly engaged in the design and installation of Solar System. The design shall be in accordance with requirements of federal, state, and local codes and standards.

B. Solar System designer and installer(s) shall demonstrate that they have successfully designed and installed at least four (4) projects within the past five (5) years that, in aggregate, equal or exceed the size of the proposed project. References shall be provided for each of the referenced qualified projects.

C. Solar equipment structural systems are to be permanently fastened to provided stainless-steel stub supports as stated in Contract Drawings. The provided design is to meet operation and installation dimension requirements and not exceed maximum load values as stated in Contract Drawings.

D. The Contractor shall comply with all NY State and local ordinances that apply to the installation of a Solar System in the proposed location.

E. Contractor shall obtain approval from Con Ed and the Town for the interconnection of the PV system with the building electrical distribution. All interconnection costs and equipment modifications shall be at the Contractor's expense.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval by the Engineer. Submittals shall include, but not be limited to:

1. Results from the system simulation using software.

   a. System energy analysis including total system DC size, annual power output, and a shading analysis

2. A list of proposed manufacturers with the products they produce proposed for the contract.

3. Manufacturer's catalog cuts for the Solar System materials proposed for use. Detailed information for components of the Solar System shall include the following:
    a. Wiring
    b. Inverter
    c. Photovoltaic Modules
    d. Rack and mount support assemblies
    e. Combiner Box
    f. Instrumentation
    g. DC and AC Disconnect Switches
    h. Monitoring Systems including interfacing with facility data collection systems
4. Scaled Shop Drawings showing proposed routing, layout, sections, and elevations of the Solar System. Shop Drawings shall include electrical ratings, one-line, three-line, grounding, dimensions, mounting details, materials, required clearances, terminations, weight, wiring and connection diagrams, accessories, nameplate data, foundations, and other required support structures.
5. Bill of Materials
6. Submittals to Electric Utility and Town
    a. After preliminary review by the Engineer, the Contractor shall submit working drawings, Solar Power Study Analysis with design calculations, Power Factor Analysis, Short Circuit Protection Studies, Solar Shading Study, Array Glare and Glint Prevention Analysis, Grid Wiring Adequacy, and/or capacities of upstream equipment to Electric Utility for approval. The Contractor shall comply with all Specifications and requirements of Electric Utility, incorporate its review comments, resubmit until approved by Electric Utility, and pay all fees and charges to connect the Solar System.
    b. After approval by Electric Utility, the Contractor shall submit working drawings, specifications and documents to the Town of Mt. Pleasant ("Town") for approval. The Contractor shall comply with all requirements of the Town, incorporate its review comments, resubmit until approved by the Town, and pay all fees and charges.

c. Final acceptance of the Solar System by the Engineer will not be granted until all documents stating that the equipment has been approved by Electric Utility and the Town are submitted to the Engineer.

7. Complete Solar System design along with Solar Power Study Analysis with design calculations shall be signed by NYS Licensed Professional Engineer.

8. Certification from the Manufacturer that the system has been seismically tested to NYSBC and New York State Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data.

9. Solar equipment structural system and connection to the stainless steel sub supports as specified within Contract Drawings shall be detailed and designed by the Contractor. Assembly reactions are not to exceed maximum values outlined in the Contract Drawings. The Contractor is to submit a design and calculation by a NYS Licensed Professional Engineer for review and For-Information-Only determination.

a. Solar equipment structural systems shall be designed for gravity, snow, wind, seismic and thermal loads as required by ASCE 7-16 and NYSBC. See Contract Drawings for wind, snow and seismic load parameters. See Specification herein for thermal load parameters.

B. Field Test Report shall be submitted.

C. Operations and Maintenance (O&M) Manuals shall be in accordance with the requirements of Section 01 78 23 – Operations and Maintenance Manuals.

D. Certifications: Contractor shall submit the following:

1. Certification by the Manufacturers of all major items of the Solar System that the system conforms to the requirements of the Contract Specifications and Drawings, and that they have jointly coordinated and properly integrated their equipment and controls to provide a complete and functional installation.

E. Certification by the Contractor that the Solar System has been properly installed, adjusted, tested, commissioned, and warrantied.

1.08 DELIVERY, STORAGE, AND HANDLING

A. All components and loose pieces shall be skidded, crated or palleted to the carriers' specifications. Further, all skids, carriers and pallets shall be enclosed in water-tight plastic wrapping, six (6) mil. minimum thickness.

B. Materials shall be delivered in Manufacturer's unopened containers identified with name, type, grade, class and all other qualifying information, including UL and other specified insurance agency's labels.

C. Master shipping list shall be supplied showing the quantity of each section, subassembly, or piece, the piece number and the Contract Drawing on which each subassembly or piece is detailed.

D. Store products in Manufacturer’s unopened packaging until ready for installation. Store the unopened equipment under environmental conditions (temperature, humidity and ventilation) within the limits recommended by the Manufacturer for optimum results. Materials shall be stored in a dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have once been wet or damaged and remove from the job Site. Panels shall not be double-stacked when shipping to avoid damage to the panels.

E. All equipment shall be prominently marked for identification in assembly. The area(s) in which the equipment is/are designated to be used shall be indicated on the shop drawings. The part identification shall be stenciled conspicuously on large pieces of equipment. Small parts shall have a metal tag wired in place with identification stamped or etched.

F. Store and dispose of solvent-based materials, in accordance with the requirements of the local authority having jurisdiction.

G. Panels shall be shipped and delivered in clearly identified bins that indicate the number of panels and nominal power per module with a manifest of each serial number contained within.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Provide all special tools necessary to disassemble, service, repair and adjust the equipment, as recommended by the Manufacturers.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. The Contractor shall obtain from the manufacturer and provide to DEP the manufacturer’s standard warranty for PV panel, PV power output, inverter, and DAS, in an acceptable form, warranting against defects in design, materials, abnormal aging, power output, and workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Solar Panel shall be as manufactured by:
   1. SunPower, X-series;
   2. Or approved equal.

B. DC-AC Inverters shall be as manufactured by:
   1. SMA Solar Technology;
   2. Or approved equal.

C. Photovoltaic Array Circuit Combiner Boxes shall be as manufactured by:
   1. SolarBOS;
   2. Or approved equal.

D. DC Solar Disconnect Switch shall be as manufactured by:
   1. Square D;
   2. Or approved equal.

E. Terminal Blocks for PV shall be as manufactured by:
   1. Phoenix Contact;
   2. Or approved equal.

F. Solar Panels Pest Barrier shall be as manufactured by:
   1. SolaTrim;
   2. Or approved equal.

G. Surge Protective Device for Solar System shall be as manufactured by:
   1. Schneider Electric;
   2. Or approved equal.

H. Power Optimizer shall be as manufactured by:
   1. SolarEdge, Fremont, CA
   2. Or approved equal.

I. Data Acquisition System (DAS) shall be as manufactured by:
   1. SMA Solar Technology;

2. SolarEdge, Fremont, CA;
3. Solar Data Systems, Inc., Bethel, CT;
4. Or approved equal.

J. DAS Monitoring Hardware shall be as manufactured by:
1. Obvius, Tualatin, OR;
2. Campbell Scientific, Logan, UT;
3. Or approved equal.

K. DAS Monitoring Software shall be as manufactured by:
1. Tangent, Kennett Square, PA;
2. Locus Energy, Hoboken, NJ;
3. BlueNRGY, Fort Lauderdale, FL;
4. Or approved equal.

L. PV Panel Mounts shall be as manufactured by:
1. Unirac;
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. The Solar System shall be fabricated to function as a complete system as specified in this Section and as shown on the Contract Drawings.

B. Solar Panel
1. The panels shall be CEC approved and UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels.
2. The panels shall be monocrystalline silicon.
3. The panels shall be Utility grade and rated for Commercial use.
4. The panels shall have following electrical criteria:

a.	Minimum Nominal Power	:	470W
b.	Power Tolerance	:	+5/-0%
c.	Min. Average Panel Efficiency	:	22%
d.	Rated Voltage	:	77.6V
e.	Rated Current	:	6A

f.	Open-Circuit Voltage	:	91.5V
g.	Short-Circuit Current	:	6.45A
h.	Maximum System Voltage	:	1000V
i.	Maximum Series Fuse	:	15A

5. Operating Condition and Mechanical Data:

a.	Temperature Range	:	-40 ºF to +185 ºF (-40 ºC to +85 ºC)
b.	Impact Resistance	:	1-inch (25 mm) diameter hail at 52 mph (23m/s)
c.	Solar Cells	:	SI Monocrystalline (128)
d.	Tempered Glass	:	High-transmission tempered anti-reflective
e.	Maximum Load Capacity for Individual Panels		
	1) Wind	:	50 psf, (2400 Pa) front and back
	2) Snow	:	112 psf,(5400 Pascal) front
f.	Frame	:	Class 2 silver anodized

C. DC-AC Inverter

1. Inverters shall be UL listed and shall include the necessary equipment, controls and accessories for the inverter to meet all code requirements and function properly as part of a power generation facility. The current UL listing applicable to inverters is UL 1741.
2. Environmental ratings shall be appropriate for Site conditions. Inverters shall be capable of operating at rated capacity at the expected ambient temperatures at the Site and at the altitude of the Site.
3. Inverters shall comply with IEEE 519 requirements for harmonics.
4. Inverter output shall be protected by an AC output circuit breaker/Fuse Disconnect switch.
5. Inverters shall communicate with the SCADA or DAS system using a common, non- proprietary protocol.
6. Inverters shall be on the CEC approved PV inverter equipment list and shall appear on the NYS PSC's certified interconnection equipment list.

7. Inverters shall include an energy metering device capable of interface with the DAS.
8. Inverters shall include an anti-islanding device (NEC Rapid Shutdown System) and DNP3-enabled communications relay (as required by the power utility).
9. Inverter shall be non-islanding type designed to shut down on loss of utility power.
10. Inverters shall be 3-phase, transformer-less.
11. The Inverter shall have following electrical criteria:
    a. Maximum DC Voltage : 1000 V
    b. Rated MPPT voltage range : 300V - 800V
    c. MPPT operating voltage range : 150V - 1000V
    d. Minimum DC voltage : 150V
    e. AC Nominal Power : As shown on Contract Drawings
    f. Nominal Output AC Voltage : 480/277 V, WYE
    g. Rated AC grid frequency : 60 Hz
    h. Minimum Efficiency : 98.2%
    i. Enclosure Rating : NEMA 12
12. Protection Devices:
    a. DC reverse polarity protection
    b. Ground fault monitoring/grid monitoring
    c. All-pole sensitive residual current monitoring unit
    d. DC Arc Fault Circuit Protection (AFCI) compliant to UL 1699B
    e. AC short circuit protection
    f. Protection class I,
    g. overvoltage category IV
    h. Surge Protection
13. Features:
    a. Rapid Shout Down
    b. LED indicators : (Status/Fault/Communication)

c. Interface : RS 485

d. Data Interface : Modbus

14. A Rapid Shutdown Box compatible with the inverter shall comply with NEC Article 690.12 which requires a rapid shutdown function for PV systems for each inverter.

15. An Energy Data logger/manager shall be provided with each inverter. The device shall be compatible with the inverter.

D. Photovoltaic Array Circuit Combiner Box

1. Contractor shall furnish and install PV Array circuit combiner box. The combiner box size and quantities, as required, with all components and accessories.

2. The combiner box shall be listed to UL 1741.

3. The combiner box shall be deadfront with internal overcurrent protection device.

4. The combiner box enclosure shall be Stainless Steel NEMA 4X.

5. The combiner box shall have minimum 8 input circuit.

6. The combiner box shall have load-break rated contactors, allowing system operators to remotely or locally disconnect the combiner under load.

7. The combiner box shall be rated for 1000V DC.

8. Combiner box shall have an integrated disconnect switch, with 90 ºC rated output terminals, and touch safe fuse holders.

9. Combiner box shall have transient surge suppression, AFCI protection, provisions for compression dual output lugs, pre-terminated input conductors, breather and drain vents, and padlockable enclosures.

E. DC Disconnect Switch

1. Switches shall be UL 98B listed for 1000VDC, and shall be wired according to the listing instructions.

2. Switches shall not be polarity sensitive – must be capable of application in either positive grounded or negative grounded systems.

3. Switched shall be bi-directional in design, and be capable of extinguishing an arc in normal and reverse current flow.

4. Switches applied for an ungrounded system shall also be bi-directional devices.

5. Switch enclosure shall be NEMA 12.
6. Switches shall be listed as "Suitable for NEC Article 690 Applications" and shall be labeled with the maximum solar string Isc per NEC calculations.
7. Switches shall provide a visible means of disconnect, independent of the side operated handle. Trailing edge of blade must be viewable when handle is in the off position.

F. PV Wires and Cables

1. PV wires and cables shall be in accordance with Section 26 05 20 - Low-Voltage Wires, Cables and Accessories.
2. Wires and cables shall be suitable for PV Solar Systems and rated for 1000V.

G. Balance of System for Electrical Connection

1. The Contractor shall include all parts necessary to make a safe and reliable connection to the facility electrical system, in accordance with the Contract Drawings.
2. The Contractor Balance of System Components may include but may not be limited to:
   a. Inverters.
   b. Power optimizers.
   c. Combiner boxes.
   d. Electrical panels.
   e. AC disconnects.
   f. DC disconnects.
   g. Conduit.
   h. Cables.
   i. Grounding conductors and connectors.
3. All exposed cables or conduits shall be sunlight/ UV resistant.
4. Signage shall be placed at the DC disconnect switch, conduit, enclosures, AC interconnection point and disconnection switch, and rapid shut down mechanism in accordance with NEC 690.
5. All DC conductors shall be listed to UL 4703.

6. Packaged solar equipment shall be secured and supported in accordance with Section 26 05 11 – General Electrical Requirements, and Section 26 05 29 - Hangers and Supports for Electrical Systems.

7. The Contractor shall provide grounding conductor connections in accordance with Section 26 05 27 – Grounding, and in accordance with NEC 250.

    a. This shall include, but not be limited to, bonding jumpers applied within the array as required based upon the racking manufacturer's installation requirements, a single ground lug for the array, equipment grounding conductor bonding the array to the local ground bar at the array point of interconnection.

8. The Contractor shall route conduits to minimize trip hazards.

9. Structural support material

    a. The support stubs for PV photovoltaic support shall be Type 316L Stainless Steel as specified in Contract Drawings.

    b. The structural sub-framing and racking shall be stainless-steel, galvanized steel, or aluminum as specified by Section 05 50 00 – Structural Steel Framing. Isolation pads or other isolating methods shall be provided between solar equipment structural systems and the stainless-steel support stubs, if dissimilar materials are used.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. Painting shall be in accordance with Section 09 91 90 – Painting.

2. All internal and external metal surfaces of all equipment shall be thoroughly cleaned, rinsed and phosphatized prior to painting.

3. The color of all interior finishing coats shall be white.

4. The color of the exterior finishing coats shall be ANSI No. 61 grey.

5. A supply of touch-up paint shall be provided from paint used for the final coat.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests

1. Certified shop test certificates for all equipment shall be submitted prior to equipment delivery as part of the Shop Drawing submission to the Engineer.

2. The Contractor shall provide panel manufacturer's results from flash testing of panels being provided. The flash test shall be conducted with an AM1.5G calibrated solar filter to approximate the sun's true spectral distribution following ASTM E927-19 Class A standards and be made available to DEP in electronic, CSV format. The results of the flash test shall include, at a minimum, the following measured values:
   a. Short-Circuit Current (Isc),
   b. Open-Circuit Voltage (Voc),
   c. Rated Current (Impp),
   d. Rated Voltage (Vmpp),
   e. Rated Power (Pmpp),
   f. Solar irradiance,
   g. Cell temperature.
   h. The flash test data shall also include the PV panels' serial numbers and associated pallet numbers.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. A complete Solar System shall be installed in accordance with manufacturer's requirements, NEC, local codes, this Section and as shown on the Contract Drawings.

B. Contractor shall interconnect the PV system with the building electrical distribution system only after receiving prior approval from Con Ed and the Town.

C. The installation of equipment and all associated wiring and interconnections shall be performed only by qualified persons.

D. Contractor shall furnish and install flashing kit, sizes and quantities, as required, for the roof mount Solar System. Flashing kit shall be suitable for the building roof material. Flashing kit shall include aluminum flash, cap that snaps onto the flash, Lag bolt/washer, continuous slot L-Feet bracket, and all bonding hardware.

E. For wiring installations, use on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections. Route the wires out of the way of windows, doors, openings, skylights, and other hazards. Ensure wires are free of snags and sharp edges that have the potential of wire damage. All conduits shall be mechanically fastened.

F. Solar System shall be adequately fastened and braced to Stainless Steel Stubs in accordance with the design and details provided by the Contractor and limitations outlined in the Contract Drawings.

G. Contractor shall refer to Contract Drawings for all parapet setback dimensions and utilize the software simulation for panel spacing.

H. Remove, replace, patch, and repair roofing materials and penetrations that are cut or damaged during installation of the Solar System. Contractor shall furnish and install all repair supplies.

3.03 FIELD TESTING / QUALITY CONTROL

A. General

1. During installation, the Contractor shall inspect hardware for defects and physical damage, labeling of NRTL and nameplate compliance with the Contract Documents.

B. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of Solar System, check the installation before it is placed into operation, assist in the performance of field tests, observe and assist initial operations.

C. After installation, the completed Solar System shall be field tested for operation and conformance. The field tests shall be witnessed by the PV manufacturer's representative and Engineer and certified by the Contractor. The Contractor shall provide testing which consist of the following:

1. Field tests shall be performed in accordance with the requirements of Section 01 75 10 - Preliminary and Final Field Tests, and per ASTM E2848 – 13 Standard Test Method for Reporting Photovoltaic Non-Concentrator System Performance.

2. Visual Inspection:

a. Compare equipment nameplate data with Contract Specifications and approved Shop Drawings.

b. Inspect physical, electrical, structural, and mechanical condition.

c. Verify required area clearances.

d. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method and perform thermographic survey after energization.

e. Verify that all cable entries from top of junction boxes are sealed per junction box rating.

3. Tests:

a. Provide test equipment required for performing tests.

b. Correct defects disclosed by the tests and repeat tests, as necessary.

c. Conduct tests in the presence of the PV manufacturer's representative and the Engineer.

d. Tests shall include, as a minimum, the following.

1. Polarity of all DC positive and negative wires
2. Open circuit voltage on each array string
3. Short circuit current on each array string
4. System operating voltages and current
5. Wire resistance
6. Grounding connections.

4. Module String Voltage Tests:

a. Prior to connecting wiring to the combiner box, use a digital multi-meter to ensure each Solar Panel series string's polarity is correct.

5. Operational Tests:

a. Perform tests in accordance with the manufacturer's written recommendations. Tests for stand-alone systems shall be performed per IEEE 1526.

D. The Contractor shall provide a Field Test Report. The report shall identify the tests performed and the results obtained.

1. Manufacturer's Site Services Man-Days Required Minimum:

a. Multiple trips may be required due to construction scheduling and equipment start-up sequence.

b. The services of the Manufacturer's representative shall be provided for Solar System as follows:

Visit Type	Min. No. of Visit(s)	Min. Number of Person(s) per Visit	Min. Number of Day(s)
Equipment Installation and Inspection	1	2	3
Field/Acceptance Tests	1	2	1
Training	1	2	1

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall perform inspections after completion of equipment installation.

B. The Contractor shall provide Solar System start-up services and training in accordance with Section 01 79 05 - Equipment Start-up and Training.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

Exhibit A

System Information Assumptions for Simulation

System Information	Value
Solar Resource Library File	Helioscope Modeling Software. Weather dataset TMY, 10km grid (41.05,-73.75), NREL
Module	SunPower X-Series - SPR-X21-470-COM
Method	Nominal Operating Cell Temp (NOTC)
Inverter	Sunny Boy 5.0 US (240V)
Inverter Efficiency	96% minimum
DC to AC ratio	1.1 minimum
Array Tilt	10 degrees
Shading	Minimal self-shading, 3D shading analysis accounts for the surrounding structures including HVAC equipment.
Losses	Includes shading, temperature, reflection, wiring, inverter, soiling and system losses.
Degradation	0.5% DC Degradation per year

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing standby power. Standby power shall be provided in accordance with the requirements specified under this Section and the Contract Drawings.

B. Standby power required under this Section shall be from diesel engine generator sets. The generator sets shall include all appurtenances for a complete functioning standby power generating system. Load banks shall be provided with standby power systems.

C. Contractor shall furnish and install two (2) 800KW, 480V, 3-phase, 0.80 pf, 1,800 RPM diesel engine generators. The new generator shall comply with the requirements of this Section and as shown on the Contract Drawings.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 05 06 00.01- Schedules for Stainless Steel Work
B. Section 05 56 00 - Metal Casting
C. Section 09 91 00 - Painting.
D. Section 23 31 14 - Metal Ducts and Accessories
E. Section 26 05 27 - Grounding.
F. Section 26 05 29 - Hangers and Supports for Electrical Systems
G. Section 26 05 53 - Identification for Electrical Systems.
H. Section 26 23 23 - Low-Voltage Switchgear
I. Section 26 23 24 - Low-Voltage Generator Switchgear
J. Section 26 29 13 - Enclosed Controllers.
K. Section 26 32 36 - Resistive Load Banks
L. Section 40 05 07 - Hangers and supports for process piping
M. Section 40 05 97 - Piping and Equipment Identification

1.04 REFERENCES

A. Definitions

1. Not used

B. Reference Standards. Standby power generator sets shall comply with the latest applicable provisions and recommendations of the following:

1. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
2. ISO 3046 - Performance Standards for Reciprocating Internal Combustion Engines
3. ISO 8528 - Reciprocating Internal Combustion Engines
4. NEMA MG1 - Motors and Generators.
5. NEMA AB1 - Molded Case Circuit Breakers.
6. NETA ATS - NETA Acceptance Testing Specification.

7.	NFPA 30	-	Flammable and Combustible Liquids Code.
8.	NFPA 37	-	Standard for Installation and use of Stationary Combustion Engines and Gas Turbines.
9.	NFPA 110	-	Standard for Emergency and Standby Power Systems.
10.	NIST	-	National Institute of Standards and Technology.
11.	NEC	-	National Electrical Code.
12.	NYSMC	-	New York State Mechanical Code
13.	NYSBC	-	New York State Building Code
14.	NYCNC	-	New York City Noise Code.
15.	UL-142	-	Steel Aboveground Tanks for Flammable and Combustible Liquids
16.	UL 508	-	Industrial Control Equipment.
17.	UL 2200	-	Standard for Stationary Engine Generator Assemblies.
18.	6 NYCRR Part 613-		Petroleum Bulk Storage Regulations
19.	DEP EHS Safe Design Guides		

1.05 DESCRIPTION

A. The generator sets shall be designed, built, and tested in accordance with the latest applicable editions of ISO 9001, NFPA, NEMA and EGSA and UL.

B. The operating environment of the generator set shall be as follows:

1.	Ambient temperature	-	40º C
2.	Height above sea Level	-	365 feet
3.	Relative Humidity	-	95%

C. The generator set shall meet the latest EPA air emission requirements applicable at the time of installation.

D. The generator set shall comply with NYCNC and NYS Building Codes.

E. The generator shall comply with Chapter 13 of the NYCMC.

F. The generator sets shall operate from No. 2 ultra-low sulfur diesel fuel and be equipped with all necessary accessories.

G. The generator sets shall be rated for continuous 24-hour per day operation, without deration, for the duration of any normal utility outage up to a maximum of 30 consecutive days.

H. The generator sets telephone influence factor shall be less than 50 in accordance with NEMA MG1-22.43.

I. The nominal ratings of the generator set including kVA, kW, power factor, voltage, number of phases, frequency, and speed of the engine generator sets shall be as shown on the Contract Drawings.

J. The generator sets shall have suitable motor starting capability to limit the voltage dip to less than 10 percent under the most severe starting conditions for designated motors when starting the motors with a miscellaneous power and lighting pre-load on line. The generator sets shall have identifying nameplates in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems. Alternator nameplates shall also be in accordance with NEMA MG1.

K. Resistive Load Banks shall be provided and shall be designed for continuous operation with a duty cycle similar to that specified for the generator.

L. The generator sets shall be designed for outdoor installations.

1.06 QUALITY ASSURANCE

A. General:

1. Each generator set shall be of current manufacture and the standard product from a firm regularly engaged in the production of such equipment specified in this Section, the Specifications or as shown on the Contract Drawings.

2. The firm shall have a minimum of 20 years' experience in designing, supplying and supporting engine generators sets.

3. Each generator set shall be factory assembled in an ISO 9001 certified engine manufacture facility and tested to determine that it is free from electrical or mechanical defects and to assure that it meets design specifications.

4. Assembly by integrators or packagers who are not the single manufacturer of the generator set engine will not be approved.

5. The engine shall be certified at the time of manufacture and carry a prominent nameplate listing all information necessary to secure an EPA Certificate of Conformity.

6. Each generator set shall be adequately guarded both physically and electrically for protection of operating personnel.

7. All materials, equipment and parts comprising each generator set shall be new, of current manufacturer and of the highest grade. All components shall be covered by the manufacturer's standard warranty on new machines.

8. The generator set manufacturer shall have complete parts and service facilities and a factory-trained technician, located within a hundred miles of the project site, available on a 24-hour basis. Services shall be readily

available so to avoid long periods of interruption or require extensive spare parts inventory.

9. The manufacturer's service representative shall be direct employee of the equipment manufacturer, with at least five (5) years of experience in the installation, testing and startup of equipment specified herein. Manufacturer's sales and marketing representatives shall not be accepted as manufacturer's service representative.

10. The generator set manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all factory tests. Calibration of testing apparatus shall be within one year.

11. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the NIST and the NETA ATS.

B. Field Tests:

1. The generator set shall be field tested. Field testing shall be performed in accordance with the requirements specified under this Section.

2. The services of the generator set manufacturer shall be retained for field service. Field service shall be in accordance with the requirements specified under this Section.

3. Retain the service of an independent testing firm who shall perform field acceptance testing of the generator set. The testing firm shall have experience in the inspection and testing of the equipment and shall be a member company of NETA.

4. Acceptance testing shall be in accordance with the requirements specified under this Section.

C. The Contractor shall hire a NYS Registered Licensed P.E. to submit the electrical equipment installation application to the local government Building Department (authority having jurisdiction). The Contractor shall be responsible for coordinating with the local government Building Department and paying all required fees. The Contractor shall be responsible to provide short-circuit, and coordination studies signed and sealed by a NYS Registered Licensed Professional Engineer to the local government Building Department. Contractor shall be responsible to submit all applicable drawings, studies, forms, catalog cuts/shop drawings for the required approvals of electrical equipment installation by the local government Building Department, and the Con Edison.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's technical information which shall include:
   a. Standard published curves of engine-generator set rating. Special or maximum ratings are not acceptable.
   b. Calculations confirming motor starting capability.
   c. Calculations confirming the sizing of all batteries.
   d. Published data of the generator line and machine constants.
   e. Published data of fuel and oil consumption estimates, based on engine manufacturer's data.
   f. Published manufacturers estimated data of cooling and combustion air flow requirements, plus heat rejection of the engine and generator when operating at full load.
   g. Proof of compliance with all local codes in particular compliance with the requirements for noise control, type of fuel to use, exhaust emissions and seismic criteria.
   h. Complete installation drawings with wiring diagrams and interconnections.
   i. Complete generator enclosure details, including equipment arrangement drawings and specifications.
   j. Manufacturers' literature, bills of materials, specifications, Engineering data and installation instructions necessary to fully describe engine-generator set and all appurtenances and to substantiate compliance with the specified requirements.
   k. Appendix A details the technical information, which shall at a minimum accompany or be a part of the technical information submitted.
2. Description of shop, field and acceptance testing methods, procedures and apparatus with calibration dates shall be submitted for approval. Shop testing shall include both witnessed and non-witnessed testing. Testing methods and procedures shall be submitted at least ninety (90) days in advance prior to conformation of each of above testing dates and actual testing.
3. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least forty-five (45) days in advance to actual testing, five (5) recent references with phone numbers shall be submitted.

B. The Contractor shall submit Generator anchorage and restraint details with design calculation signed and sealed by NYS Licensed Professional Engineer to Engineer

for their review and approval. The anchorage and restraint details shall be coordinated with the manufacturer.

C. After review by the Engineer the Contractor shall submit drawings of the generator set drawings and proposed installation to the Fire Department of Town of Mount Pleasant for review and approval.

D. Complete load bank including load bank controller and the interconnection arrangements required between the generator and the load supplied.

E. Certificates of Compliance

1. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

F. Reports

1. Shop test and field test reports shall be submitted.

2. Manufacturer's site visit and acceptance testing reports shall be submitted.

G. Operation and Maintenance manuals covering all equipment provided shall be submitted in accordance with this Section and the Specifications. The Operation and Maintenance Manuals shall at minimum contain:

1. Manuals and procedures annotated to show or describe only the specific equipment installed.

2. Complete As-Built Drawings

3. Material Summaries

4. Component Instruction

5. Sequence of Operation

6. Complete Nameplate Schedule

1.08 DELIVERY, STORAGE, AND HANDLING

A. Generators and accessories shall be delivered, stored and handled in accordance with this Section, the Specifications, the generator manufacturer’s instructions and the following:

1. Generators shall be inspected for shipping damage when received.

2. All sleeve or oil lubricated bearings generators shall be identified, and the bearing reservoirs filled to normal level.

3. Generators shall be handled using base lifting lugs. Avoid pounding or bumping of generator which may damage unit. A hoist and spreader bar arrangement shall be used to avoid damage.

4. Generators shall be stored indoors in clean, dry heated areas. Provisions, such as the energization of heaters, shall be made to prevent moisture from condensing within or on the generator set and its accessories.

5. Generators shall not be stored in areas subject to continuous vibration. A small quantity of grease shall be injected into each bearing on a monthly basis. Purged grease shall be inspected for water or rust.

6. The Contractor shall provide the service of a manufacturer's representative authorized to witness and advise on the unloading of the generator set and all accessories at site.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts, special tools and supplies for the generator sets.

B. The spare parts, special tools and supplies shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts, special tools and supplies shall be furnished in accordance this Section, the Specifications and the manufacturer's recommendations for the generator size and type.

D. Spare parts which shall be provided shall include at a minimum the following:

1. Two (2) complete sets of air, oil and fuel filters of each type and size used.

2. One (1) complete set of belts and hoses of each type and size used.

3. Two (2) sets of control power fuses of each type and size used.

4. Two (2) per ten pilot lights of each size and type used.

E. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the generators furnished under this Section for a period of one year after acceptance.

1. As a minimum, there shall be provided sufficient oil and grease to make a least one lubricant change for each generator as applicable.

2. Replace all lubricants used during startup and testing prior to acceptance of equipment. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

1. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Engine generator sets shall be as manufactured by:
   1. Caterpillar Inc., Peoria, IL;
   2. Cummins Inc., Columbus, IN;
   3. Or approved equal.

B. Generator set enclosure shall be as manufactured by:
   1. Lectrus, Chattanooga, TN;
   2. Or approved equal.

C. Engine governor shall be as manufactured by:
   1. Woodward Inc., Loves Park, IL;
   2. Or approved equal.

D. Engine sub-base fuel tank shall be as manufactured by:
   1. Lectrus, Chattanooga, TN;
   2. Or approved equal.

E. Alternators shall be as manufactured by:
   1. GE, Fairfield, CT;
   2. Cummins Generator Technologies, Fridley;
   3. Or approved equal.

F. Alternator voltage regulator shall be as manufactured by:
   1. Basler Electric Company, Highland, IL;
   2. Or approved equal.

G. Load Banks shall be as manufactured by:
   1. Simplex Company, Springfield, IL;
   2. ASCO, Cleveland, OH;
   3. Or approved equal.

H. Battery Chargers shall be as manufactured by:
   1. Basler Electric Company, Highland, IL;
   2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Engine

1. Each generator set shall include an engine. The engine shall be configured for generator set service and be of the internal combustion-diesel type. The engine shall be equipped to operate on ultra-low sulfur diesel fuel and include radiator cooling, with engine driven water pump, expansion tank with temperature control modulating valve, lube oil pump, lube oil coolers, air filters, fuel filters and temperature and pressure gauges to monitor the charge air system, the jacket water systems and the lube oil system.

2. Without any overloading and with all the engine and alternator accessories active the net horsepower of the engine at the rated speed, shall not be less than that required to produce the rated kW output at the ambient temperature and altitude specified.

3. The engine shall be constructed with cast iron cylinder heads and steel backed bearings. Pistons shall be aluminum alloy with chrome faced rings. The engine crank case shall be reinforced cast iron. The crank case shaft shall be forged alloy steel with hardened journals, finished and dynamically balanced.

4. The engine shall be equipped with speed governing system which includes a solid state isochronous governor. The governor shall maintain frequency within 1/4 percent of its mean value for constant loads from no load to full load. The engine shall have a 3 seconds maximum transient recovery time for one-step load acceptance and a 7 percent maximum transient frequency dip on one-step application of a 0.8 power factor load at 80 percent of unit full load rating. Where multiple generating set are required to be run in parallel to satisfy the load requirement the governor requirements shall be as specified.

5. The speed governing system shall be equipped with the following provisions:

   a. Overspeed shutdown

   b. Engine over crank shutdown,

6. Engine cooling system shall consist of an engine-mounted radiator with blower type fan, sized to maintain safe operation. The coolant system shall be filled with a 50 percent solution of ethylene glycol, water and rust inhibitor.

7. Engine cooling system shall also comprise an engine driven, centrifugal type circulating water pump, thermostatic valves to maintain the engine at the recommended temperature and be equipped with the following accessories.

a. High engine temperature shutdown.

b. Loss of coolant shutdown.

c. Coolant level sensors.

d. Cooling water temperature gage.

e. Coolant drain line with valve.

f. Fan guard.

g. Radiator face duct connection.

8. The engine radiator shall be remote mounted in a vertical or horizontal configuration.

9. Remote mounted radiators shall be designed for low noise operation with fan driven by a totally-enclosed fan cooled electric motor.

10. The engine shall be equipped with jacket water heaters. Heaters shall be in be in accordance with the following:

a. Thermostatically controlled, of sufficient capacity to keep the jacket water at a suitable temperature for trouble-free starting over the range of the ambient temperature specified in this Section.

b. Heater shall be provided with a suitable contactor to automatically disconnect the heater when the engine is started. Heater shall operate at 120 VAC single phase.

11. Engine lubrication system, including engine driven lube oil pump, shall be equipped with the following accessories:

a. Lube oil temperature gage.

b. Lube oil pressure gage.

c. Oil level indicator.

d. Low oil pressure shutdown.

e. Oil drain lines with valves

12. Engine fuel system shall operate with No. 2 ultra-low-sulfur diesel fuel and consists of all piping and valves required between the engine and subbase tank. The system shall include a fuel pressure gage.

B. Alternator

1. Each generator set shall be provided with an alternator. The alternator shall be engine-driven, single or two bearing type, 60 Hz, synchronous, revolving field with brushless excitation and drip-proof, guarded construction. The alternator shall be coupling connected to the engine flywheel housing to ensure permanent alignment.

2. The alternator shall be self-ventilated and have one piece cast aluminum alloy low noise cooling fan.

3. The windings' insulation shall be Class H in accordance with NEMA MG1. The stator winding shall be non-hydroscopic, fungus resistant, tropicalized and shall be given multiple dips and bakes of varnish under vacuum, plus a final coating of epoxy for extra moisture and abrasion resistance. Unless otherwise specified, temperature rise shall not exceed 130 degrees C rise over 40 degrees C ambient.

4. The rotor shall be dynamically balanced and include amortisseur windings to minimize voltage deviations and heating effects under unbalanced load conditions.

5. The alternator shall be equipped with a static electronic voltage regulator to maintain voltage within plus or minus 1/2 percent under load, from no load to 100 percent load. The regulator shall also maintain the random voltage variation for constant loads within plus or minus 1/2 percent under load, from no load to 100 percent load.

6. The alternator shall be equipped with an excitation support system. The system shall consist of a permanent magnet exciter to provide a dedicated source of power for the exciter field. The permanent magnet exciter shall isolate the excitation system and sustain 300 percent short circuit current, under any short circuit condition, for up to 10 seconds.

7. The alternator shall be equipped with space heaters. Space heaters shall be 120-volt, single phase, of sufficient wattage to maintain the temperature approximately 5 degrees above ambient when the generator is idle. Space heaters shall be disconnected when generator is running.

C. Air Supply/Exhaust System

1. Each generator set shall be provided with an air supply/exhaust system. The air supply/exhaust system shall consist of a heavy duty air cleaner, silencer and exhaust piping of suitable size, configuration and material in accordance with engine manufacturer's recommendations. The exhaust systems shall include ports for emission testing.

2. Exhaust piping shall be welded schedule 40 stainless steel with standard bend radius and stainless steel flexible exhaust fittings. All indoor exhaust piping shall be insulated to maintain a surface temperature not to exceed 50 degrees C.

3. The exhaust silencer shall be critical grade type or better to meet the required sound attenuation specified, and shall be constructed of double plate sheet with condensate drain ports. The inlet and outlet ANSI flanges

shall be Type 304 SS. The connection to the engine shall be a stainless steel expansion joint and if required the outlet also.

D. Starting System

1. Each generator set shall be provided with a battery system. The battery system shall consist of batteries, cables and a battery charger and shall be used for engine starting, powering the engine control module and powering electric actuators, instrumentation and protective devices.

2. Batteries shall be long life, heavy duty lead acid type, with number of cells, voltage and rating in accordance with requirements of the engine manufacturer. The batteries shall be sized for a minimum of six (6) crank cycles of the specified engine and have sufficient current available for break-away of the particular engine at worst case temperature while at the same time powering the other peak connected loads.

3. Battery cables and connectors shall connect the starting motor and the generator control panel to the battery supply.

4. Battery charger shall be automatic float type, current limited with 120 volts, 60 Hertz input. The battery charger shall be capable of recharging a discharged battery in 12 hours while carrying normal loads. The battery charger shall be equipped with the following additional features and accessories:

   a. Equalizing switch and equalizing timer.

   b. DC ammeter.

   c. DC voltmeter.

   d. DC cranking disconnect relay.

   e. Low-high DC voltage alarm relay.

   f. Current failure relay.

5. The battery system shall be provided with a suitable rack for mounting batteries and battery charger.

E. Fuel System

1. Subbase Fuel Tank:

   a. Each generator set shall be provided with a dual wall subbase fuel tank. The subbase fuel tank shall be reinforced steel, subbase construction suitable for integral mounting within the generator set structural steel base.

   b. The subbase tank shall be constructed in accordance with NFPA 30, NFPA 37 and NFPA 110. The subbase tank shall be UL-142 listed. CSA C282-09 and B139-04 installation compliant.

c. Direct reading fuel level gauge. Port for access to containment tank. Emergency vents on primary and secondary tanks are sized in accordance with NFPA 30, external to enclosure.

d. installed fuel level indication at the generator set control panel.

e. seismic certification per applicable building codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007.

f. The subbase tank shall include fittings and vents as required for fuel supply, return, manual fill, normal and emergency venting. The subbase tank shall be treated with two coats of rust inhibiting primer and two coats of standard finish paint.

g. The subbase tank capacity in gallons shall be 2,000.00 gallons. Dual wall, secondary containment shall be minimum of 110% of primary tank capacity.

h. The subbase tank shall be equipped with the following additional features and accessories:

a) Leak detection switch.

b) Low fuel level switch.

c) High fuel level switch.

i. The subbase tank shall be equipped with immersion heaters. Heaters shall be in accordance with the following:

a) Thermostatically controlled, of sufficient capacity to keep the fuel temperature at 50 degrees F above the ambient temperature stated in this Section.

b) Heater shall be provided with a suitable contactor to automatically disconnect the heater based upon temperature and if the fuel level decreases to the heater level. Heater shall operate at 120 VAC single phase.

F. Control Panel

1. Each generator set shall be provided with a unit-mounted control panel. The control panel shall include the necessary controls, instruments, and lights to manually and automatically start, stop and monitor the generator unit.

2. The control shall be UL 508 listed. The panel control shall be microprocessor based with programmable adjustments and shall provide monitoring, metering and control of the system based upon the manufacturer's standard arrangement. Control power to the panel shall be DC supplied from the starting battery system.

3. The panel controls shall include the following:
   a. Automatic engine starting control from a single pole contact which closes for engine run and opens for engine stop.
   b. Automatic cranking controls to disconnect engine while running.
   c. Four, 7 seconds minimum, cranking cycles with cranking attempts separated by appropriate rest periods.
   d. Cranking controls shall be locked out, requiring manual reset, if engine fails to start at the completion of the starting program.
   e. Overspeed shutdown.
   f. Overcrank shutdown.
   g. 0 to 60-minute adjustable timer for cool down after the transfer of load to utility power.
   h. Three (3) Position Selector Switch: Manual Start-Off-Auto Start and Start-Stop Pushbuttons.
   i. Voltage adjusting rheostat.
   j. Auxiliary contacts for controlling generator space heaters.
4. The panel malfunction protection, status and alarm indicators and accessories shall include the following:
   a. Shutdown and alarm annunciation:
   b. Engine high water temperature.
   c. Engine low oil pressure.
   d. Engine overspeed.
   e. Engine overcrank.
   f. Low coolant level.
   g. Alarm annunciation without shutdown:
   h. Engine low water temperature.
   i. Engine high water temperature pre-alarm.
   j. Engine low oil pressure pre-alarm.
   k. Battery charger malfunction.
   l. Subbase tank low level.
   m. Subbase tank high level.
   n. Subbase tank leak.

5. Normally open contact, common for all alarm conditions, for remotely indicating generator malfunction.
6. Normally open contact, for remotely indicating generator run.
7. Wattmeter and power factor meter.
8. Elapsed time meter.
9. Ammeter, voltmeter, and phase selector switches.
10. Frequency meter.
11. Oil pressure and temperature gauges, coolant temperature gauge and battery voltmeter.
12. The unit mounted control panel shall be completely pre-wired. All instruments, controls and indicating lights shall be suitably mounted and properly identified. All wires and terminals shall be individually identified.
13. The panel controls shall be arranged to accept a stop signal from a remote stop station. The remote station shall provide emergency shutdown of the generator set.

G. Circuit Breakers

1. The generator set shall be provided with unit mounted main circuit breaker and exciter circuit breaker, sized for protecting the unit.
2. Circuit breakers shall be in accordance with the requirements of Section 26 29 13 – Enclosed Controllers.

H. Enclosure

1. The generator sets shall be provided with a protective enclosure. The enclosure shall completely enclose the entire generator set, including subbase tank, starting system and air supply/exhaust system.
2. Protective enclosures shall be walk-in type as shown on the Contract Drawings.
3. Walk-in type enclosures shall be custom built for proper access of all components within. Dimensions shall be based upon actual furnished equipment. The equipment arrangement, shall at a minimum, provide 3 feet clear from the generator frame to the front of the deepest wall mounted panel or enclosure. Walk-in type enclosures shall be in accordance with the following:
    a. The enclosure shall be pre-painted aluminum stressed skid construction consisting of the following:

b. The roof shall consist of one piece roof sheet, .040-inch-thick, 3003 aluminum alloy with extruded aluminum recessed side and end rails and I beams, 6061-T6 alloy.

c. The side walls and end walls shall be formed from panels, .050-inch-thick, 5052 H-34 aluminum sheet, riveted 3 inches on center, with extruded aluminum post sections on 24 inch centers.

d. The floor and underframe shall consist of two 6 inch wide flange I beam longitudinal skids with 10 gauge steel crossmembers on 12 inch centers, overlayed with 3/4 inch tongue and groove exterior FIR plywood subfloor surfaced with 1/8 thick diamond plate steel.

e. Doors shall include an aluminum frame and personnel door fully gasketed to form a weather tight seal.

4. Louvers shall be provided and sized as required for sufficient engine combustion and radiator cooling. Louvers shall be motorized and of aluminum construction riveted into the steel frame forming a rigid water resistant assembly.

a. The enclosure shall be completely wired with the following accessory equipment:

b. A 120/208 volt, single phase load center panel with circuit breakers for all power requirements including lighting, convenience receptacle, battery charger, subbase tank, and heaters.

c. Vapor tight lighting fixtures within the enclosure with a snap switch at the entrance door.

d. Duplex convenience receptacle.

e. Battery-powered emergency lighting fixture positioned to light the engine starting controls.

5. The generator enclosures shall provide sound attenuation of 80 dB(A) at 3ft. from the generator enclosure.

I. Painting

1. All ferrous metal surfaces shall be cleaned and painted with a rust inhibiting primer. All exterior surfaces shall be given three coats of manufacturer's standard finish paint. Finish paint shall be suitable for the operating temperature.

2. Color of finish paint shall be ANSI No. 61 gray (medium gray).

3. Generator enclosures when required shall be primed with two coats of zinc-chromate. The enclosure exterior shall be finished painted with three coats of enamel. Color of finish paint to be selected by Engineer from manufacturer's standard color chart.

J. Load Banks

1. Resistive Load Banks shall be in accordance with the requirements of Section 26 32 36 - Resistive Load Banks.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the generators at the manufacturer's plant prior to shipment.
2. Shop test shall be in accordance with the latest revisions of NEMA MG1 and shall demonstrate that the equipment tested conforms to the requirements specified and shown on the Contract Drawings and the corresponding approved submittals.
3. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.
4. The completed generator set for each unit shall be tested at the manufacturer's factory. The generator set shall be tested for a period of two hours at full load, 0.8 power factor with suitable load banks.
5. The test may include the manufacturer's standard test procedure, but at minimum shall include the following:
    a. Verify generator set assembly, prior to operation, including all mechanical and electrical connections.
    b. Verify fuel and lubrication systems are clean and filled with proper grades of fuel and lubricants.
    c. Make adjustments as required to governor and voltage regulator controls.
    d. Inspect operation of all gauges, switches, and meters. Verify generator set monitoring meters against calibrated load bank meters.
    e. Verify operation of all safeties and alarms.
    f. Maintain records of unit operation, at 15-minute intervals, for duration of test.
    g. Records at a minimum shall include, jacket water temperature, oil pressure, ambient air temperature, voltage, current, frequency, kilowatts, and power factor.

B. Witnessed Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with this Section and the Specifications.

2. The test may include the manufacturer's standard test procedure, but at minimum shall include the following:
   a. an inspection
   b. a loading test.
3. The inspection shall include:
   a. Verify generator set assembly, prior to operation, including all mechanical connections and arrangements, all electrical connections, all test connections, and all test equipment locations.
   b. Verify fuel and lubrication systems are clean and filled with proper grades of fuel and lubricants.
   c. Static verification of all safeties and alarms.
4. The load test shall include the operation of the generator on suitable load banks to achieve a 0.8 power load and stabilization of all temperatures over three consecutive recording periods at 100% as follows:
   a. Maintain records of unit operation, at 15-minute intervals, for duration of test.
   b. Records at a minimum shall include, jacket water temperature, oil pressure, ambient air temperature, voltage, current, frequency, kilowatts, and power factor.
   c. Inspect operation of all gauges, switches, and meters.
   d. Verify generator set monitoring meters against calibrated test instrumentation.
   e. Make adjustments as required to governor and voltage regulator controls.
   f. 30% load for half an hour
   g. 50% load for half an hour
   h. 75% load for half an hour
   i. 100 % load for two hours
   j. 100% load rejection and acceptance tests
5. The Certified Test shall be completed and approved before the scheduling of the Witnessed Test.
6. The Contractor shall provide a Witnessed Shop Test report. The report shall identify the tests performed and the results obtained.
7. The generator set/s shall not be shipped until Witnessed Shop Test report has been approved by the Engineer.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Install generator sets in accordance with the manufacturer's instructions and recommendations.

B. The generator set shall be mounted on a common structural steel frame base. The base shall be provided with vibration isolators consisting of steel springs in combination with rubber pads and anchor bolts. Anchor shall be in compliance with the manufacturer's recommendations.

C. A template shall be furnished by the manufacturer for setting anchor bolts, pipe sleeves, and nuts for mounting the isolators to the concrete foundation. Stainless steel bolts and nuts shall be furnished for bolting the isolators to the channel frame base of the engine-generator set.

D. Flexible connections shall be provided between the generator set and all off-skid supply and return lines, supply and discharge ducts, electrical power, control and instrumentation conduits and other externally connected support systems.

E. Provide services of a qualified factory representative to inspect in detail the installation of the generator set and related auxiliary systems prior to the commencement of Field Tests detailed in this Section.

3.03 FIELD TESTING / QUALITY CONTROL

A. Filed Tests

B. After installation, generator sets and systems associated with, such as load banks shall be field tested for operation and conformance.

C. The Contractor shall perform field tests in accordance with this Section, the Specifications, and the Contract Drawings.

D. The field tests shall be witnessed by the Engineer and certified by the Contractor.

E. Generator set testing shall be performed by the manufacturer's representative, prior to energizing equipment. Equipment shall not be energized without the permission of the Engineer. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall include at a minimum demonstrate the following:

1. That the entire installation has been made in accordance with the approved manufacturer's drawings, and that the unit and all auxiliaries are ready for operation.

2. That fuel and lubrication systems are complete, clean, and filled with the proper grades of fuel and lubricants.

3. That the units and all subsystems start, operate, and shutdown in accordance with manufacturer's recommendations.

4. That all safeties, alarms and shut-downs function at the correct set point and sequence.

5. That the unit accepts load, governs speed, and regulates voltage.

F. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the generator sets, check the generator set installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the generator sets.

2. The Contractor shall provide equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

   a. Minimum number of manufacturer's representative site visits per type of engine generators:

Visit Type	Minimum Number of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation and Inspection	1	3	5
Field Tests	1	3	5
Startup	1	2	3
Training	1	2	2

3. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

4. The Engineer shall have the right to reallocate any unused person-days.

5. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted,

problems corrected, tests results, training, instruction, and all other pertinent information.

6. The service representative shall sign in and out with the Engineer on each day they are at the site. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. Acceptance Testing

1. The Contractor shall provide acceptance testing of the generator sets.
2. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section and preliminary approval of the Operation and Maintenance Manual.
3. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.
4. Acceptance testing shall be performed on each generator set. Each set shall be tested in load increments using portable resistance type load banks or plant loads or combination of the two. Testing shall include the following:
   a. Perform functionally tests to verify generator set shutdown features operate as required.
   b. Perform vibration base line test.
   c. Unit shall be operated for a simulated power failure test. Tests shall be initiated by simulating a failure of the normal supply. Tests shall end by returning normal supply.
   d. Apply the actual plant loads available plus load banks necessary to total full load. Unit shall be load tested, 30 minutes at 25 percent load, 30 minutes at 50 percent load, 30 minutes at 75 percent load and three hours at 100 percent load.
   e. At each load increment the test duration shall not commence until all generator set engine and alternator temperature show no more than one-degree change over three successive 5 minute period.
   f. Records shall be maintained, at 5-minute intervals, for duration of each test.
   g. Records at a minimum shall include fuel consumption, water temperature, oil pressure, ambient air temperature, voltage, current, frequency, kilowatts, power factor and sound level at 3 ft. from each side of the enclosure.

B. Acceptance electrical testing shall be performed on each alternator. Testing shall include the following:

1. Insulation-resistance tests shall be performed on each alternator winding with respect to ground.

2. Determine polarization index.

C. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.

D. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

APPENDIX A:

The information listed below represent the minimum technical content which shall be a part of submittals to be made for the generator set.

Engine Data:

1. Manufacturer
2. Model
3. Number and arrangement of cylinders
4. RPM
5. Bore and stroke
6. Piston displacement (cubic inches)
7. Maximum engine power at rated rpm
8. Brake mean effective pressure (BMEP) at rated kW (including any parasitic loads and alternator efficiency)
9. Piston speed (ft./min), materials of construction, fan performance, motor details
10. Make and model of governor
11. Make and model of over-speed shutdown device
12. Maximum allowable exhaust back pressure (inches water column)
13. Engine cold cranking amps
14. Guaranteed fuel consumption rate:
    a. Full load (gal/hr)
    b. Three quarters load (gal/hr)
    c. Half load (gal/hr)

Alternator Data:

1. Manufacturer
2. Model
3. Rated kVA, Rated kW
4. No of Wires
5. Voltage, Frequency
6. Temperature rise above 40 degrees C ambient

   Stator by thermometer (degrees C)

Field by resistance (degrees C)

7. Class of insulation
8. Alternator sub-transient reactances X1, X2, X0 and other reactances and resistances (P.U. on machine KVA base)
9. Motor starting capability
10. Alternator efficiency including excitation losses and at 80 percent power factor:
    d. Full load (percent)
    e. Three-quarters load (percent)
    f. Half load (percent)

Generator unit and accessories:

1. Weight of skid mounted unit (pounds)
2. Overall length (inches)
3. Overall width (inches)
4. Overall height (inches)
5. Exhaust connection size (inches)

Guaranteed Engine exhaust gas emission data maximum values (not to exceed) at full prime load, ¾ load ½ load and ¼ load:

1. Temperature (degrees F)
2. Flow (ACFM)
3. Carbon Monoxide (CO) (grams/BHP-hr)
4. Nitrogen Oxides (NOx) (grams/BHP-hr)
5. Volatile Organic Compounds (VOC) (grams/BHP-hr)
6. Sulfur Dioxide (S02) (grams/BHP-hr)
7. Particulates (grams/BHP-hr)

Engine heat rejection (BTU/min)

1. Heat radiated to room by engine
2. Heat to jacket coolant
3. Heat to oil cooler
4. Heat to after cooler
5. Heat to exhaust
6. Heat to fuel

7. Radiator fan rate (CFM)

Coolant data:

1. Jacket coolant flow rate (gpm)
2. Jacket coolant outlet temperature (degrees F)
3. Maximum allowable jacket coolant return temperature (degrees F)
4. Aftercooler coolant flow rate (gpm)
5. Aftercooler coolant outlet temperature (degrees F)
6. Maximum allowable aftercooler coolant return temperature (degrees F)
7. Total coolant required for replacement (gallons)
8. Engine heat rejection (BTU/min)
9. Combustion air volume (CFM)
10. Height from bottom of skid required for removing piston with connecting rod (also for removing cylinder liner) (feet)
11. Nominal ampere-hour rating and cold (-30 degree F) cranking amps of the starting battery(ies), (AH), (CCA) and sizing data for batteries.

Radiator:

1. Air flow rate (cfm)
2. Fan horsepower (bhp)
3. Fan blade tip speed (fps)
4. Fan noise rating at 50 feet (dbA)

END OF APPENDIX A

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place into satisfactory operation air-cooled, outdoor weatherproof resistive load banks for use in loading emergency generator sets.

B. The load banks shall be suitable for application to 3-phase, 3 or 4-wire, 60 Hz systems with voltage ratings as shown on the Contract Drawings.

C. The load banks shall be complete with vacuum contactors for load step switching and all auxiliary equipment as shown on the Contract Drawings and specified in this Section.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 - Painting

B. Section 26 05 11 – General Electrical Requirements.

C. Section 26 05 27 - Grounding

D. Section 26 05 53 – Identification for Electrical Systems

E. Section 26 05 91 – Low-Voltage Motors

F. Section 26 08 11 – General Electrical Testing.

G. Section 26 23 24 – Low Voltage Generator Switchgear

H. Section 26 32 13 – Engine Generators.

I. Section 26 36 23 – Automatic Transfer Switches.

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.

2. The Electric Utility is Con Edison.

3. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volt and within the 600 V Class.

4. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 volts and below 99,000 volts.

B. Reference Standards

1.	IEEE C37.20.2	-	Metal-Clad Switchgear.
2.	IEEE C37.90	-	Relays and Relay Systems Associated with Electric Power Apparatus.
3.	IEEE C37.90.1	-	Surge Withstand Capability (SMC) Tests for Relays and Relay Systems Associated with Electric Power Systems.
4.	IEEE C37.90.2	-	Withstand Capability for Relay Systems to Radiated Electromagnetic Interference from Transceivers.
5.	NEMA SG 4	-	Alternating Current High-Voltage Circuit Breakers.
6.	NYSBC	-	New York State Building Codes.

7.	NEC	-	National Electrical Code.
8.	NYSNC	-	New York State Noise Code.
9.	UL 508	-	Industrial Control Equipment.

1.05 DESCRIPTION

A. The Contractor shall provide fully functional, metal-clad, arc-resistant, outdoor, non-walk in, load bank assemblies as shown on the Contract Drawings and as specified herein and shall consist of the following at a minimum:

1. Independent resistive load stacks comprising load elements for each phase.
2. Resistive load elements shall be contained in integral cases permitting the removal of individual resistors for inspection or service.
3. Cooling fans for each load stack capable of drawing air through the load stacks from the bottom up and exhausting the hot air at the top of the enclosure.
4. Low-voltage vacuum contactors for load step control
5. Microprocessor based control panels.
6. Protective devices inclusive of devices to limit or curtail load bank operation under various fault scenarios.
7. Enclosure capable limiting the touch temperature of the enclosure to that of ambient temperature.
8. Exhaust Plenums to direct exhaust air away from the load bank installation.

B. The Contractor shall provide all necessary communication requirement, wiring, contacts, terminal blocks, protective relays, switches, etc. as required for proper operation, whether shown or not.

C. The load banks shall have electronic metering, monitoring and communications as described in this Section and Section 26 09 13 - Electrical Monitoring and Communication Systems.

1.06 QUALITY ASSURANCE

A. The load bank manufacturer shall be the manufacturer of all the major components of the load bank as specified in this Section, the Specifications and as shown on the Contract Drawings.

B. The manufacturer of the load bank equipment shall have produced load banks for a minimum period of the last continuous fifteen (15) years.

1. The Contractor shall provide list of at least five (5) installations with similar equipment, to that which will provided under this contract, and demonstrating compliance with these requirements.

2. The Contractor will provide the name, address, telephone number and email of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning, and operation of the equipment at the above listed five installations.

C. All load bank equipment shall be new, within six (6) months of manufacture and comply with the requirements of this Section, the Specifications, and the Contract Drawings.

D. The load bank manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

E. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure that each load bank and its components are designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings.

F. The load bank manufacturer shall have provisions and operate facilities for the collection and disposal, reuse, or remediation of all components of the load bank.

G. The load bank equipment shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, the Utility and NEC.

H. Whenever applicable, all work regarding the load bank equipment shall conform to the requirements of the Utility.

1. The Contractor shall hire a NYS Registered Licensed P.E. to submit the application to the local government. The Contractor shall be responsible for coordinating with the NYS Building Codes, Electrical Plan Review Group, paying all required fees. The Contractor shall be responsible to provide short-circuit and power system coordination study signed and sealed by a NYS Registered Licensed Professional Engineer to local government. Contractor shall be responsible to submit all applicable drawings for the required approvals including approval required by the Local government AHJ, and the Utility.

2. The costs of the drawing submission and any resubmissions shall be included in the lump sum price bid for the work under this Contract.

I. Nameplates conforming to Section 26 05 53- Identification for Electrical Systems shall be provided for all components of each load bank installation.

1. Nameplates shall clearly indicate information in accordance with NEMA and IEEE requirements.

2. Nameplates shall be engraved or embossed on stainless steel.

J. The Contractor shall retain the services of the load bank manufacturer's representative to certify that the load bank installation is in accordance with the manufacturer's requirements.

K. All rack structures shall be fabricated of code gauge steel.

L. Seismic Requirements

1. The load banks shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the NYSBC.

M. Testing

1. Load Bank manufacturer shall use a shop test facility that has calibrated testing apparatus and qualified experienced technicians for all shop tests.
2. Calibration of all testing apparatus shall be within one year.
3. Shop Testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.
4. Field Testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.

N. All test equipment, instrument calibration and test reports shall be in accordance with the latest edition of the accuracy standard of NIST and NETA ATS.

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Certified copy of the manufacturer's Design Tests conducted on load bank models and type similar to that is being offered for this contract.
2. Certified dimensioned outline drawings showing equipment layouts, front and side views and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.
4. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.
5. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.
6. Complete erection, elevation, layout, and installation drawings for all items of equipment specified in this Section.

7. Elementary Diagrams and Interconnecting Wiring Diagrams having their terminals identified and indicating the internal wiring and all control and switch developments.
    a. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable.
    b. Separate drawings for each equipment/compartment shall be supplied.
    c. Wire lists in lieu of wiring diagrams shall not be acceptable.
8. Separate drawings for each load bank shall be supplied including individual load stack point-to-point wiring diagram.
9. Complete three-line diagrams detailing connections for all instrument transformers, relays, meters, etc.
10. Complete Bill of Material.
11. Details of special features.
12. Instruction manuals of all protective relays for the equipment.
13. Nameplate schedules.
14. Recommended spare parts list with pricing.
15. List of Special Tools.
16. Painting Procedures.
17. List of recommended lubricants.
18. Preliminary Operation and Maintenance manuals.
19. Finalized Operation and Maintenance manuals.
20. Final Copy Working Drawings (FCWD)
    a. FCWDs shall be completed in accordance with the Specifications and submitted at the completion of Final Field Testing.
21. Certificates of Compliance/Manufacture.
    a. Provide letter signed in the presence of a notary attesting that the manufacturer satisfies qualifications stated in this Section.
22. Reports.
    a. All shop test and field test reports.
    b. All manufacturer's site visit reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Load banks shall be delivered, stored, protected, and handled in accordance with the manufacturer’s instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

C. Load banks shall be shipped and delivered in convenient shipping splits, each split not to exceed four (4) feet in length.

1. Each split shall be mounted on shipping skids and wrapped for protection.

2. Sections shall be provided with additional removable stays and braces designed to enable the sections to withstand any forces of deformation encountered up to and including movements to install the load bank on its final installation pad.

3. Bus bars with associated hardware for connections between shipping splits shall be shipped inside the splits in which it shall be installed.

4. Shipping splits shall contain accessories to permit handling by cranes.

5. Where cranes are not available it shall be possible for splits to be skidded into final positions on rollers and using jacks to raise and lower.

D. Exhaust systems

1. Exhaust channels and plenums intended for connection to the load bank enclosure shall be packaged and shipped separately.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools and supplies with the load bank and associated equipment, neatly wrapped, or boxed, indexed, and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

D. Furnish in addition the following spare parts:

1. One (1) set of complete replacement of power fuses for each load bank assembly.

2. One (1) set of complete replacement indicating lamps for each load bank assembly.

3. One (1) set of complete replacement color caps lamps for each load bank assembly.

4. One (1) of each type of protection relay for each load bank assembly.

5. Two (2) complete sets of fuse replacements of each rating and type installed as part of potential transformer primary and secondary for each load bank assembly.

6. Two (2) complete sets of fuse replacements of each rating and type installed as part of control power transformer primary and secondary for each load bank assembly.

E. Furnish the following protective equipment and tools:

1. The Contractor shall furnish one (1) set each of protective equipment and tools for each load bank installation.

2. Protective equipment shall consist of:

   a. Flash Coat shall be 6oz. NoMex minimum with Velcro fasteners
   b. Arc Hood shall be rated 75 cal/cm^2 with UV and Infrared Protection
   c. Rubber Gloves shall be rated minimum 40,000V with leather protection.
   d. Face Shield shall be rated 7.33 cal/cm^2
   e. Safety Helmet
   f. Safety Glasses
   g. Carrying case for the above equipment

3. Protective tools shall consist of:

   a. Grounding Stick
   b. Voltage Tester
   c. Hot Sticks
   d. Grip All Clamp Stick
   e. Grounding Clamps, Ball and Socket ASTM Type 1, Class A, Grade 5
   f. Ground Stud Covers

F. Furnish the following tools for each load bank installation:

1. One (1) set of specialized wrenches and tools as required for proper installation, operation, and maintenance.

2. One (1) infrared inspection system per site for thermo-graphic inspection of the power cable terminations or bus connections with the doors closed.

3. One (1) set of drawout device extension rails. Rails shall be capable of being made integral to the load bank switchgear cubicle and/or breaker transfer truck.

4. Two (2) sets of test plugs and cables for testing the controller while removed from the compartments.

5. One (1) test stand per site capable of accommodating each size breaker provided.

6. Two (2) levers' for manually racking and charging the breaker.

7. One (1) Breaker Lifting Yoke used for attachment to breaker for lifting breaker on or off section rails.

G. Lubricants

1. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the equipment furnished under this section for a period of one (1) year after acceptance.
   a. Replace all lubricants used during start-up and testing prior to acceptance of equipment.
   b. Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Load Banks shall be as manufactured by:
   1. Asco Avtron, Cleveland, OH;
   2. Simplex Inc., Springfield, IL;
   3. Or approved equal

B. Load Bank resistive elements shall be as manufactured by:
   1. Asco Avtron, Cleveland, OH;
   2. Or approved equal

C. Load Bank Controller shall be as manufactured by:
   1. AVTRON,
   2. Or approved equal

D. Vacuum breakers shall be as manufactured by
   1. ABB, New Berlin, WI;
   2. Schneider Electric Andover, MA;
   3. Or approved equal

E. Vacuum contactors shall be as manufactured by
   1. ABB, New Berlin, WI;
   2. Schneider Electric, Andover, MA;
   3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Resistive load banks shall continuously rated as follows:

1. KW rating as shown on the Contract Drawings,
2. 480/277 Volts, 1.0pf, 3-phase, 3-wire, 60 Hz.
3. Relative Humidity, 95% condensing
4. Max altitude 5000 ft above sea level
5. Min Wind Speed, 35 mph
6. Max Wind Speed 75 mph
7. Comply with seismic requirements of NYSBC.
8. The overall tolerance of the load bank shall be -0% to +5% kW at rated voltage.
9. Load bank load tolerances such as -5% to 5% which allows loads less than rated are not acceptable.
10. The load bank enclosures in conjunction with the specified air inlet and exhaust systems at rated load, rated voltage and with all fans working shall achieve the following sound level attenuation under site ambient noise:
    a. 82 dBA at 3 feet from the enclosures
    b. 82 dBA at 5.5 feet from the top of the enclosure.
11. The load bank shall comply with NYSNC.
12. The maximum temperature and relative humidity are likely to occur simultaneously.
13. The generator set shall be provided with a load bank for periodic exercising, testing, and maintaining the unit.
14. Each generator set installation shall be provided with load banks to test and maintain the units.
15. The load bank shall meet the latest applicable NEMA, NEC, and ANSI standards. The load banks shall be UL standard 508A listed.
16. The load banks shall be continuously duty rated, resistive type, permanently installed with capacity, voltage and number of phases matched to the generator set specified. The load bank shall operate in temperature of -20º F to 120°F.
17. The load bank enclosure shall be stationary, free-standing suitable for outdoor installation.
18. The enclosure shall be equipped with screened air intakes and hinged doors for access to load elements and control devices.
19. The load banks shall include the following additional features:
    a. Bus bar terminal block connections.

b. Resistive elements arranged in steps with contactors, branch circuit fuses and load control circuits.
c. Digital controller to protect system during malfunctions.
d. Forced air cooling system with fan, motor, and combination motor starter.
e. Voltmeter, ammeter, frequency, and kiloWatt (kW) meter.
f. The load bank shall be equipped with sound attenuators. The sound attenuation system shall be able to reduce the noise to a level that will meet minimum regulatory standards or requirements. The load bank noise attenuation requirements shall meet the generator set enclosure noise reduction requirements.

20. Circuit Breaker

a. The load bank shall be connected to the generator switchboard bus by a circuit breaker as shown on the Contract Drawings.
b. Circuit breaker shall be in accordance with the requirements of Section 26 29 13 – Enclosed Controllers.

B. Resistive Load Elements

1. All materials used in the mounting and installation of the resistive load elements shall be suitable for the temperatures encountered both in normal operation and under fault conditions.

2. Resistive load elements shall be contained in integral cases permitting the removal of individual resistors for inspection or service.

3. The resistive load elements shall be of helically wound nickel chromium alloy wire specifically insulated for the rated load bank voltage.

4. The ohmic value of each phase of the 3-phase circuit for each load step shall not be more than 2% difference from the average ohmic value of the 3 phases of the circuit.

5. Individual elements shall be derated to carry no more current than half of the current rating of the wire when the load bank is carrying its maximum load.

6. Elements shall be fully supported across the entire length of the air stream by ceramic insulators on stainless steel rods.

7. Element supports shall be so designed to prevent sagging or adverse movement and prevent a short circuit to adjacent conductors or to ground.

8. The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.

9. The resistive elements shall not require a cool down period.

C. Cooling

1. Each load bank stack shall be provided with integral mounted blower fans driven by low-voltage motors.
2. Blower motor control, protection, starters and disconnect switches shall be located in an auxiliary panel in the low-voltage section of the load bank.
3. Blower motors shall comply with Section 26 05 91 – Low-Voltage Motors.
4. Blower motors shall be TEFC, directly coupled to the fan blades.
5. Fan blades shall comprise an airfoil design and be capable of withstanding corrosive environments.
6. The resistive elements of the load bank shall be air cooled by a properly size self-contained cooling fan.
7. The fan motor shall be protected against overload using an overload device and short circuit protected using current limiting fuses with AIC rating as shown on Contract Drawings.
8. If there is a loss of cooling air and the load bank temperature is very high, the load bank shall be electrically isolated from the rest of the system.

D. Load Step Switching

1. Load step switching shall be provided by low-voltage contactors.

E. Local Control Panel

1. Provide each load bank with a programmable logic controller (PLC) based load bank Control Panel.
2. The Control Panel shall be a separate metal enclosed unit.
3. The Control Panel shall be accessible from the outside.
4. The entire Control Panel including the PLC shall be completely suited for installation outdoors in a weatherproof enclosure.
5. Provide an integrated digital display in each load bank control panel capable of monitoring line and phase parameters such as:
    a. Current, voltage, power, vars, harmonics and power factor.
    b. Provide the appropriate potential and current transformers.
6. Provide the enclosure with a space heater to prevent condensation in the control panel.
7. Provide the following manual and automatic controls and indications with each control panel:
    a. Manual controls at the control panel shall consist of the following:
        1) Power ON/OFF selector switch

2) Power ON indicator light

3) Fan ON light

4) Fan fault light

5) Air loss/High temperature light

6) Local/Remote (this Local/Remote switch shall take precedence over the control room switch).

7) Auto/Manual/Off-Reset

8) Blower start/stop pushbuttons

9) Master load on/off switch to facilitate switching of the full block load of entire load bank.

10) Individual load step toggle switches, one for each load step as shown on the Contract Drawings.

b. Automatic controls at the Control Panel shall determine the following:

1) Load demand of all loads connected to the various busses.

2) Load supplied by all generators connected to the generator bus and feeding loads.

3) Load bank load connected and running on the system.

4) Determination of the quantity of load bank step load to add or remove from the system to allow all running generator to be loaded to at least 60% of their rating.

5) When the Load Bank and Generators have stabilized at a particular plant load point to satisfy the 60% criteria then reduction or addition of plant load shall cause the load bank controller to add or remove a similar quantity of load bank load.

6) Load bank load additions or reduction shall occur after a suitable delay from the change in plant load.

c. Provide at a minimum the following LED indicating lights at the control panel:

1) Auto/Manual/Off

2) One for each Blower on.

3) Loss of airflow

4) Over Temperature

5) One for each load step that is switched into the circuit.

6) Amber fault lights

F. Control Panel at a Remote Point

1. Provide a selector switch for each load bank control panel consisting of the following:

a. Local/Remote

1) "Remote" shall initiate control from the Remote-Control Panel in the "Auto" mode, provided the load bank control panel is locally selected to "Auto'.

2. Provide indicating lights for each load bank at the Remote-Control Panel/Point consisting of the following:

a. Local/Remote
b. Auto/Manual/Off.

G. Protective Features

1. Provide a differential air pressure switch for each cooling air flow path through the load bank to detect loss of cooling air flow.

2. Provide an over temperature switch for each cooling air flow path through the load bank to detect an over temperature condition.

3. Electrically interlock the pressure and temperature switches with the load controls to prevent load from being applied if cooling air flow is not present or if an over temperature condition exists.

4. Should a loss of air flow or an over temperature condition occur in any air flow path, all load step contactors shall be disabled.

5. Provide branch circuit fuses on all three phases of switched load steps.

6. Branch fuses shall be current limiting type with an interrupting rating of 200 kA symmetrical.

H. Automatic Load Controller

1. The automatic load controller shall be equipped with load step switches and will use the load bank as a supplemental load to maintain a minimum load on the generator set. The automatic load controller shall monitor the connected downstream loads and shall automatically add or subtract load steps in response to downstream load changes as to maintain a minimum load level on the generator set. The controller shall include an initial time-delay circuit, and automatic time delayed load step application circuit. The automatic load controller shall monitor the switchgear load using the current transformers, and automatically adjust the load steps of the load bank in order to maintain the optimum load required for safe operation of the generator. The Contractor shall furnish and install current transformers on

the generator switchgear bus bars for sensing the total running load current connected from switchgear bus.

2. The automatic load bank controller shall start the load bank by turning on the blower. After a time delay (typically 2 to 5 seconds), the controller begins adding load steps, with a time delay between the addition of each step. The load steps are added in sequence, usually from smallest to largest and removed in reverse sequence; first on/last off, last on/first off.

3. The generator switchgear load is continually monitored by means of a current transformer placed between the load bank and the generator switchgear.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Enclosure

1. The load bank enclosure shall be constructed of 7-gauge plate steel (3/16) on the structural members and 14-gauge steel (minimum) on the non-structural members (such as access panels, etc.), making a rigid, drip proof structure.

2. Provide inspection windows to facilitate unrestricted closed-door view of all the resistive elements by infrared instruments.

3. All exterior fasteners shall be type 316 stainless steel.

4. Cooling air shall be drawn in from the bottom intake end of the load bank, forced across the resistor elements and exhausted from the top of the load bank.

5. Airflow through the load elements shall be vertical.

6. Suitable and adequately sized protection shall be mounted on the intake and exhaust of the load bank airflow stream to prevent foreign objects from entering the load bank.

7. Provide appropriate warning/caution labels and appropriate danger signs on access doors and panels in clearly visible locations.

8. All labels and signs shall be provided with Section 26 05 53 – Labelling and Identification for Electrical Systems.

9. The load bank enclosure shall be stationary, free-standing, weatherproof suitable for outdoor installation and rated NEMA 3R. The enclosure shall be equipped with screened air intakes, exhaust opening, and hinged doors for access to load elements and control devices.

B. Arrangement

1. Each Load Bank shall consist of:

a. The low-voltage section shall contain:

1) low-voltage breaker
2) Resistive load element sectionalized, and heat insulated from the rest of the low-voltage components.
3) Cooling fans
4) Suitably formed cooling duct passages to permit drawing cool air from the bottom of the load bank and venting hot air at the top of the load bank.
5) Resistive load elements switching contactors.
6) Local Control panel
7) All low-voltage section protective devices and sensors.

C. Painting

1. All equipment shall be shop and field painted in accordance with Section 09 91 90 – Painting.
2. All internal and external metal surfaces of the load bank shall be thoroughly cleaned, rinsed, and phosphatized prior to painting.
3. The load bank shall be painted with a thermosetting electrostatically applied polyester powder with final baked on average thickness between 1.5 to 2.0 mils.
4. The color of all interior finishing coats shall be white.
5. The color of the exterior finishing coats shall be ANSI No. 61 grey.
6. The finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363 and shall pass ASTM B117 5% salt spray test for a minimum of 1000 hours.
7. A supply of touch-up paint shall be provided from paint used for the final coat.
8. Stainless steel surfaces shall not be painted but shall be prepared and covered with plastic sheets for protection during painting.
9. Interior surfaces which are not accessible after assembly shall be painted prior to assembly.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Each load bank shall be completely assembled, wired and tested at the factory, including all buses, connections, insulator, terminals and terminal blocks, to demonstrate that it has been properly assembled, properly lubricated, is not overheating, is not overloading and has no electrical or mechanical defects.

2. Shop testing shall be performed on the load bank at the manufacturer's plant prior to shipment.

3. Shop test shall be in accordance with the latest revisions of IEEE and shall demonstrate that the equipment tested conforms to the requirements specified.

4. The load bank and the automatic load controller shall be shop tested in the presence of the City Engineers. The tests shall include standard electrical functional testing, verifying conforming to the assembly drawings and specifications.

5. The Contractor shall provide a Certified Shop Test report.

    a. The report shall identify the tests performed and the results obtained.

6. Resistive load bank certified shop tests shall include the following:

    a. Verification of the load bank arrangement, assembly and construction against approved submittals and shop drawings.
    b. Verification of accuracy and recording of all the load step resistance values by application of less than rated extra low-voltage voltage and measurement of corresponding current flow.
    c. High potential testing to verify the complete electrical isolation of the load bank elements from control circuits.
    d. Verification of the complete electrical isolation of load bank elements from ground.
    e. Complete electrical functional testing of the load bank and controls

        1) Functional testing shall include verification of the functioning of all protective devices at set points and rise and fall of monitored quantities around the setpoints.

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests

3. The Contractor shall obtain approval of the testing procedure and test stand layout prior to scheduling a witness shop test.

4. For the Witnessed Shop Test the Contractor shall perform all of the Certified Shop Tests in the presence of the witnesses.

5. The Contractor shall provide a Witnessed Shop Test Report.

    a. The report shall identify the tests performed and the results obtained.
    b. The Contractor shall submit and obtain acceptance by the Engineer of the witness shop test report prior to shipment of the equipment.

C. Load Bank shall not be shipped before the approval of the Witnessed Shop Test Report.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Load Bank equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. Load Bank equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Load Bank equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

D. Steel channels shall be provided for support of Load Bank equipment.

E. Load Bank equipment shall be securely mounted to mounting surface with anchor bolts.

F. Anchor Load Bank to satisfy the specified seismic requirements in accordance with the anchorage details.

G. Install nameplates for identification of Load Bank equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, load banks shall be field tested for operation and conformance.

2. The Contractor shall perform field tests in accordance with the Specifications, Section 26 08 11 – General Electrical Testing and this Section.

3. The field tests shall be witnessed by the Engineer and certified by the Contractor.

4. Load bank testing shall be performed by the manufacturer's representative, prior to energizing equipment.

5. Equipment shall not be energized without the permission of the Engineer.

6. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:

a. Inspections:

1) Load bank sections shall be checked to determine that they have been properly installed, lubricated, and connected.

2) Physical, electrical, and mechanical condition shall be inspected.

3) Proper anchorage required area clearances, physical damage and proper alignment shall be checked.

4) Ventilating air passageways shall be inspected for blockage.

5) All connections shall be inspected for high resistance.

6) Electrical and mechanical interlock systems shall be checked for proper operation.

7) Insulators shall be inspected for evidence of damage or contamination.

8) Equipment shall be cleaned and lubricated as required.

b. Electrical testing:

1) Resistance of load bank resistive elements shall be measured using less than rated extra low voltage applied voltage and measurement of corresponding current flow.

a) Results shall be recorded and compared with factory test results.

b) Significant variations shall be brought to the attention of the Engineer and corrected by the Contractor at additional cost.

2) Ground-resistance tests shall be performed.

3) Insulation-resistance tests shall be performed on each bus section, on each switch, transformer and circuit breaker, phase-to-phase, and phase-to-ground.

4) An over potential test shall be performed on each bus section, each phase-to-ground and on each switch in the closed position. Test each pole with other poles grounded.

5) Control and metering wiring performance test shall be performed.

6) Device settings and adjustments shall be verified.

7) Functional tests verifying the operations of all controls and displays.

7. Each load bank shall be loaded and tested as follows:

a. 50% load for ½ hour
b. 75 % load for ½ hour
c. 100% load for one hour
d. All voltages, currents and temperature of the intake and exhaust shall be recorded at five-minute intervals.
e. For minor equipment trouble that is encountered during load testing, load testing may be continued through completion provided there are no personnel or equipment hazards as a result of the trouble.
f. Minor equipment trouble shall be fixed and load bank re-tested for at 100% load for at least one (1) hour of trouble free operation.
g. Infrared testing shall be performed during the final hour of trouble free operation and a second time after full load has been applied continuously during the acceptance testing.

B. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the Load Bank, check the Load Bank installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation and maintenance of the Load Bank.

2. The Contractor shall provide Load Bank equipment start-up services and training in accordance with this Section, the Specifications and the Contract Drawings and the following requirements:

3. Minimum number of manufacturer's representative site visits per Resistive Load Bank:

Visit Type	Minimum Number of Visits	Number of Person(s)	Minimum Number of Days
Equipment Installation and Inspection	1	2	3
Field Tests	1	2	3
Acceptance Testing	1	2	3
Training	1	2	2

4. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

5. The Engineer shall have the right to reallocate any unused person-days.

6. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.
    a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.
7. The service representative shall sign in and out with the Engineer on each day they are at the site.
    a. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide Load Bank start-up services and Training in accordance with this Section and the Specifications.

1. Acceptance Testing
    a. The Contractor shall provide acceptance testing of the load bank.
    b. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.
    c. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.
    d. Acceptance testing inspection shall be performed on each Load Bank.
    e. Acceptance Testing shall include the following:
        1) Four (4) continuous hours of trouble-free running at 100% load.
        2) Operation of all systems associated the load banks and complete functional testing.
        3) All functional testing shall be restricted to the first hour of the four (4) hours run and include the following:
            a) All load bank control panel functions for exercising and automatic load addition/shedding during normal operation of the generators.
            b) Remote manual and automatic control of each load bank.
            c) System control from the central control point.
            d) Local and remote monitoring and alarm.
            e) Any additional tests required by the Plant Superintendent or the Engineer.

f) Failure to complete all functional testing shall cause the additional time to be added back to load run.

f. All tests and values shall be in accordance with the manufacturer's recommendations.
g. The Contractor shall provide an acceptance testing report.

2. Training

a. The Contractor shall provide training on the load bank operation.
b. All training shall be in accordance with the Specifications. Training shall be based on load bank manufacturer's training or Operations and Maintenance (O&M) manuals.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, test and place into satisfactory operation Central Battery System(s) (CBSs) as shown on the Contract Drawings and as specified in this Section.

B. Furnish and install the CBSs with all auxiliary equipment and accessories as shown, specified and /or required for the proper operation of the following:

1. New 15 kV switchgear lineups.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 26 05 11	-	General Electrical Requirements
B.	Section 26 05 27	-	Grounding
C.	Section 26 05 48	-	Vibration and Seismic Controls for Electrical Equipment
D.	Section 26 05 53	-	Identification for Electrical Systems
E.	Section 26 13 26	-	Medium-Voltage Metal-Clad Switchgear

1.04 REFERENCES

A. Definitions

1. All references to the Electric Utility or the Utility shall mean the Local Electric Utility having jurisdiction.
   a. The Electric Utility is Con Edison.
2. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation at less than 1000 volt and within the 600 VAC Class.
3. Medium-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation above 1000 volts and below 99,000 volts.
4. NIST as used in this Section and the Specifications shall mean the National Institute of Standards and Technology.
5. Vented battery/cell as used in this Section and the Specifications shall mean a battery/cell in which the products of electrolysis and evaporation are allowed to escape freely to the atmosphere.

B. Reference Standards

1.	IEEE 450	–	Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications
2.	IEEE 484	–	Design and Installation of Vented Lead-Acid Batteries for Stationary Applications

3.	IEEE 485	–	Sizing Lead-Acid Batteries for Stationary Applications
4.	IEEE 1375	–	Guide for Protection of Stationary Battery Systems
5.	IEEE 1491	-	Selection and Use of Battery Monitoring Equipment in Stationary Applications
6.	NYSBC	-	New York State Building Codes.
7.	NEC	-	National Electrical Code.
8.	NETA ATS	-	NETA Acceptance Testing Specifications.
9.	NEMA PE5	-	Utility Type Battery Chargers
10.	UGS	-	Utility Governing Specifications.

1.05 DESCRIPTION

A. The CBS shall be used to supply switchgear for breaker control, protective devices and their control circuits, DC supply to power circuits, Normal and Emergency Lighting or similar applications.

B. The CBS shall comprise batteries made up of individual cells, battery racks, redundant battery chargers, DC distribution panels and DC automatic transfer switches.

C. CBSs for switchgear and protective device applications shall be independent of CBSs supplying other applications such as Normal and Emergency Lighting.

D. CBSs are required by the UGSs.

E. The CBS shall be rated as follows:

1. Nominal Operating Voltage, 125 VDC.
2. System configuration, 2 wire, ungrounded.
3. Nominal volts per cell, 2.0 VDC
4. Float Voltage per cell, from 2.23 to 2.27 VDC
5. Final Voltage at end of discharge cycle per cell, 1.75 VDC
   a. Final Battery Voltage shall be computed as N multiplied by Final Voltage per cell.
   b. N is the number of cells in each CBS battery.
6. Ambient Temperature Range, -20 to 50 degree Centigrade

a. Temperature Rating point for all calculations, 25 degree Centigrade.

b. All calculations shall be corrected to 25 degree Centigrade.

7. Nominal capacity of each cell shall be based on the following performance:

a. Starting with cells fully charged at the Float Voltage and with the battery charger disconnected and the ambient temperature not less than 40 degrees C, and the actual discharge capacity set at 80% of the rated capacity, the CBS and the constituent cells shall be capable of supplying the required duty cycles with the battery voltage not falling below the Final Battery Voltage.

b. The Approval of the Engineer shall be required to satisfy the nominal capacity with multi-string batteries.

1.06 QUALITY ASSURANCE

A. The CBS manufacturer shall be the manufacturer of all the major components of the CBS as specified in this Section, the Specifications and as shown on the Contract Drawings.

B. All CBS equipment shall be new within six (6) months of manufacture and complying with the requirements of this Section, the Specifications, and the Contract Drawings.

C. The manufacturer of the CBS equipment shall have produced CBSs for a minimum period of the last continuous fifteen (15) years.

D. The CBS manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

E. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure that each CBS and its components are designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings.

F. The CBS manufacturer shall have provisions and operate facilities for the collection and disposal, reuse, or remediation of all components of the CBS.

G. The CBS equipment shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, the Utility, NEC and Local government requirement.

H. The Contractor shall provide list of at least five (5) installations with similar equipment, to that which will provided under this contract, and demonstrating compliance with these requirements.

1. The Contractor will provide the name, address, telephone number and email of the Company representative who can speak to enquires in the relation to the procurement, installation, commissioning, and operation of the CBS equipment at the above listed five (5) installations.

I. Whenever applicable, all work regarding the CBS equipment shall conform to the requirements of the Utility.

1. The Contractor is responsible to submit all applicable drawings for the required approvals including the local government EAB and the Utility.

2. The costs of the drawing submission and any resubmissions shall be considered to be included in the lump sum price bid for the work under this Contract.

J. All DC cable splicing and CBS equipment terminations shall be done by experienced installers who have worked with similar DC cable for a period of at least five (5) years, using materials and procedures recommended by the CBS manufacturer.

K. The Contractor shall retain the services of the CBS manufacturer's representative to certify that the CBS installation is in accordance with the manufacturer's requirements.

L. Where CBSs are to be installed to confirm with the Contract or Utility requirements, each CBS shall be physically separated from other CBSs in conformity with Utility requirements and/or as shown on the Contract Drawings.

M. Each CBS shall be arranged in segments.

N. All rack structures shall be fabricated of code gauge steel.

O. Seismic Requirements

1. The CBS shall be designed, constructed, and installed suitable for earthquake regulations in accordance with the seismic requirements of the NYS Building Codes.

P. Testing

1. CBS manufacturer shall use a shop test facility that has calibrated testing apparatus and qualified experienced technicians for all shop tests.

2. Calibration of all testing apparatus shall be within one year.

3. Shop Testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.

4. Field Testing shall comply with the requirements in this Section, the Specifications, and the Contract Drawings.
    a. All test equipment, instrument calibration and test reports shall be in accordance with the latest edition of the accuracy standard of NIST and NETA ATS.

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to, the following:

1. Certified copy of the manufacturer's Design Tests made in accordance with IEEE 485 and conducted on CBS models and type that is being offered for this contract.
2. Certified copies of the CBS battery sizing calculations including the following:
    a. Performance characteristics showing charging and discharging for the specified duty cycles.
    b. Power consumption
    c. Estimated average power and peak power demand.
    d. Available short circuit current, maximum continuous current and maximum voltage ratings of the battery system.
    e. Performance curves of average cell terminal voltage versus time for required duty cycles.
3. Certified dimensioned outline drawings showing equipment layouts, front side and back views and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
4. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.
5. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.

6. Weight of the CBS batteries, battery rack and battery chargers and all associated equipment and distribution on the foundation support of the static, impact, and other loads.
7. Erection drawings and procedures.
8. Detailed Elementary, Schematic, Wiring and Interconnecting Diagrams showing the arrangement, size and location of all electrical interfaces point having their terminals identified and indicating the internal wiring and all control and test switch developments.
9. Common Elementary and Interconnection Wiring Diagrams shall not be acceptable.
10. Wire lists in lieu of wiring diagrams shall not be acceptable.
11. Separate customized drawings for each CBS shall be supplied including individual rack point-to-point wiring diagram.
12. Complete two-line diagrams detailing connections for all batteries, protective devices, switches, relays, meters, etc.
13. Complete Bill of Material.
14. Details of special features.
15. Manufacturer published discharge curves for each CBS.
16. Instruction manuals of all protective relays for the equipment.
17. Nameplate schedules.
18. Recommended spare parts list with pricing.
19. List of Special Tools.
20. Painting Procedures.
21. List of recommended lubricants.
22. Seismic Criteria
    a. Calculations demonstrating compliance with NYS Building Codes.
23. Operation and Maintenance Manuals
    a. Preliminary Operation and Maintenance manuals.
    b. Finalized Operation and Maintenance manuals.
24. Certificates of Compliance/Manufacture.

a. Provide letter signed in the presence of a notary attesting that the CBS satisfies the requirements stated in this Section.

25. Reports.

a. All shop test and field test reports.

b. All manufacturer's site visit reports.

C. Contractor shall hire a NYS Registered Licensed P.E. to submit the application to the NYS Building Codes Electrical Plan Review Group. The Contractor shall be responsible for coordinating with the local government, New York State Building Codes, Electrical Plan Review Group, paying all required fees. The Contractor shall be responsible to provide short-circuit and power system coordination study signed and sealed by a NYS Registered Licensed Professional Engineer to the local government, New York State Building Codes. Contractor shall be responsible to submit all applicable drawings for the required approvals including approval required by the local government, New York State Building Codes, Electrical Plan Review Group, and the Con Edison.

1.08 DELIVERY, STORAGE, AND HANDLING

A. CBSs shall be delivered, stored, protected, and handled in accordance with the manufacturer’s instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

C. CBSs shall be shipped and delivered in convenient shipping splits, each split not to exceed thirty (30) feet in length.

D. Each split shall be mounted on shipping skids and wrapped for protection.

E. Bus bars with associated hardware for connections between shipping groups/splits shall be shipped inside one of the groups/splits in which it shall be installed.

F. Shipping splits shall contain accessories to permit handling by cranes.

G. Where cranes are not available it shall be possible for splits to be skidded into final positions on rollers and using jacks to raise and lower.

H. CBSs shall be stored indoors in a clean, level, dry and cool location.

I. Cells should not be stored for more than the time period recommended by the manufacturer without application of a freshening charge to the battery.

J. CBS batteries shall be delivered with a minimum of 90% capacity charge.

K. Exhaust systems

a. Exhaust channels and plenums intended for connection to the CBS rooms shall be packaged and shipped separately.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for CBS in accordance with the requirements of this Section, the Specifications.

B. The Contractor shall furnish for the CBS, all spare parts as recommended by the manufacturer.

C. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

D. Deliver all spare parts, tools and supplies with the CBS and associated equipment, neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

E. Furnish in addition the following spare parts:

1. One (1) set of complete replacement power fuses for each CBS.
2. One (1) set of complete replacement indicating lamps for each CBS.
3. One (1) set of complete replacement color caps for lamps for CBS.
4. One (1) of each type of protection relay for each CBS.
5. One (1) spare breaker for each size provided for each CBS.
6. Two spare batteries without electrolyte for each CBS.
7. The complete volume of electrolyte plus 10% extra volume required to fill all the spare batteries provided.
    a. The spare electrolyte shall be furnished in containers suitable for long term storage.

F. Furnish the following protective equipment and tools:

1. The Contractor shall furnish one (1) set each of protective equipment and tools for each CBS.
2. Protective equipment shall conform to the requirements of the Operating Bureau (BWS) Environmental Health and Safety requirements.
3. Personnel protective equipment shall at the minimum consist of:
    a. Safety Goggles
    b. Face shields

c. Acid-resistant gloves.

d. Protective Apron

e. Protective Overshoes

f. Carrying case for the above equipment

4. Furnish the following tools for each CBS installation:

a. One (1) set of specialized wrenches and tools as required for proper installation, operation, and maintenance.

b. One (1) infrared inspection system for thermo-graphic inspection of the inter-cell cable, bus connections and terminations.

c. One (1) cell lifting device to permit transfer of cells from racks to trucks or worktables.

d. One (1) mobile test stand capable of accommodating 6 cells.

5. Lubricants

a. The Contractor shall furnish as part of the bulk lubricant order the quantity of lubricants required to operate and maintain the CBS equipment furnished under this section for a period of one (1) year after acceptance.

1) Replace all lubricants used during start-up and testing prior to acceptance of equipment.

2) Furnish this replacement lubricant in addition to the lubricants included in the bulk order.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. CBSs shall be as manufactured by:

1. Exide, Columbus, GA

2. C&D Technologies, Attica, IA.

3. Yuasa Battery, Inc., Laureldale, PA.

4. Or approved equal.

B. Spill Containment Systems shall be as manufactured:

1. EnviroGaurd, Montclair, CA.
2. Or approved equal.

C. Ground cable set for use with ball studs shall be as manufactured by:

1. AB Chance, Centralia, MO
2. Or approved equal.

D. Infrared thermometers shall be as manufactured by

1. Fluke, Phoenix, AR
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Batteries

1. The CBS batteries shall consist of individual cells in injection molded, transparent, flame-retardant, heat-resistant, acid-resistant durable and impact resistant jars of clear styrene acrylonitrile copolymer. The Central Battery System shall meet the requirements of Section 26 13 26 – Medium-Voltage Metal Clad Switchgear.
2. The CBS shall consist of sufficient number of cells to provide nominal floating voltage at rated current as specified in this Section and as shown on the Contract Drawings.
3. The cells shall be heavy-duty, vented lead-acid (VLA) flooded design with solid copper, lead-plated posts.
4. The cells shall have a minimum of twenty (20) years of life under normal usage. The battery output shall be 125 Volts DC.
5. The positive plates shall be no less than 0.30 inches thick.
    a. The positive plates shall be bridge hung to allow for grid growth without compromising jar integrity.
    b. The plate separators shall be made of microporous rubber.
6. The jar cover shall be made of material with a minimum Limiting Oxygen Index of 28%.
7. Each cell shall be equipped with self-resealing flame arresting safety vents.
    a. The vent shall permit water addition without its removal.

8. The covers shall be of materials compatible with the jars and cemented in place to provide a permanent leak-proof seal.
9. One positive and one negative post shall be provided per cell.
10. The cell posts shall be bolted with lead plated copper bars using stainless steel hex-head nuts.
    a. The polarity of cell terminal posts shall be clearly and permanently identified.
    b. The cell posts shall be designed with two seals.
    c. The bottom seal shall be an acid resistant epoxy to fix the cell post to the post well insert.
    d. The top seal shall be an O-ring design allowing the entire seal structure freedom of movement due to changes in internal cell pressure, temperature aging, shipment, and seismic events.
    e. Neither seal shall use heat for adhesion.
11. The batteries and the system components shall be sized and supplied by the switchgear manufacturer. Batteries shall be racked and mounted in a cabinet located in the battery room as shown on the Contract Drawings.
12. Batteries shall be sized to carry the continuous load requirements for eight (8) hours when the AC power is not available and shall be able to close all breakers at the end of the eight-hour period.
13. Capacity in ampere-hours shall be based upon the worst-case summation of the continuous, noncontinuous, and momentary loads of the switchgear including the spares, plus the future switchgear and panel requirements.
14. The batteries ampere-hours shall be based upon the eight (8) hours steady load, plus the specified sizing criteria, consisting of a 15 % safety factor, 25% aging factor, and 80% derating factor.
15. Connectors
    a. Inter-cell connectors shall be of lead coated copper busbar.
    b. Inter-rack and inter-tier cables shall be flexible insulated stranded copper conductors with hydraulic compression lugs.
    c. Nuts, bolts, and washers shall be 316 Stainless Steel.

B. Battery Chargers
1. Each CBS shall be provided with its own battery charger.

2. Each battery charger shall be sized to carry 150% of the total load and comply with NEMA PE5.
3. The total load shall comprise the maximum of the continuous, non-continuous, momentary, and other miscellaneous loads connected to the CBS during float or equalize operation the battery charger.
4. Where particular CBSs are designed to pick up additional loads due to failure of another other CBS, then the total load shall take into account this additional duty.
5. Battery Chargers shall enable the CBS to meet the requirements in this Section under the following conditions and without derating:
    a. Ambient temperature range, 0-to-122-degree F.
    b. Noise level 65 dBA, measured at 5 ft from any vertical surface of the charger.
    c. Maximum Altitude, 3000 ft.
    d. Maximum Relative Humidity (RH), 95% non-condensing.
6. Battery chargers shall be suitable for the batteries specified and shall have sufficient capacity to recharge the discharged batteries in eight (8) hours while carrying normal system loads and shall also include a 50 % spare capacity.
7. The battery charger shall incorporate magnetic circuitry and rectifiers suitable to carry continuous and intermittent loads up to the rated output with plus or minus ½ % voltage regulation.
8. Battery chargers shall be equipped with a microprocessor based alarm, multimode equalize timer, and monitoring display package including the following features at a minimum:
    a. Led indicating lights
    b. Float/Equalize selector switch with indicating lights.
    c. Manual equalize timer (0-255 Hr) with indicating lights.
    d. AC line failure automatic equalize timer (0-255 Hr) with indicating lights.
    e. AC On indicating light.
    f. Membrane front panel
    g. Digital meter for VDC, Amps DC, timer hours and alarm settings.

h. Self-diagnostics

i. Alarms for reporting of fault conditions remotely and locally. Alarms shall be adjustable with time delay and include:

1) AC power failure

2) Low DC current

3) Low DC voltage

4) High DC voltage

5) High DC voltage shutdown

6) Positive and negative ground

7) Over current

8) Common alarm, for each fault condition.

j. Alarms for remote indication shall include one (1) set of form C contacts. Common alarm for remote indication shall include two (2) sets of form C contacts.

9. AC Input shall be as follows:

a. Voltage: 480 V, 3phase, 4 wire 60 Hz

b. Input Tolerances

c. Voltage, +10% to -12%

d. Frequency, +5% to -5%

e. Efficiency, better than 90% at rated voltage over 50 to 100% load range

f. Switching and protection, circuit breaker

10. DC Output

a. Nominal Voltage, 130 VDC

b. Continuous current output, 110% rated current at max equalize voltage at 122-degree F.

c. Current Limit adjustment, 50% to 110% rated.

d. Regulation at +/- 0.5% VDC

e. Ripple, less than 100 mVrms.

11. Provides filtered output under rated terminal conditions with the batteries disconnected.
12. Microprocessor controlled SCR charger.
13. Comply with IEEE C37.90.1 with both oscillatory and fast transient waveforms with 2500-volt peak.
14. Monitoring and Alarming: The following minimum monitoring and alarm features shall be provided independent of the controlling microprocessor:
    a. High DC voltage
    b. Low DC voltage
    c. AC failure
    d. DC failure
    e. Positive ground fault
    f. Negative ground fault
    g. Local and remote voltage sensing.

C. Protection
1. Each CBS shall incorporate suitable rated AC input circuit breaker.
2. All CBSs shall incorporate suitably rated DC circuit breakers as shown on the Contract Drawings and for connection of the following at a minimum:
    a. Main breaker for connection to its DC distribution system
    b. Tie Breaker for connection to dual or redundant system
    c. Battery charger
    d. Spare breaker to permit connection of suitably rated load bank for testing both the batteries and the battery charger either separately or together.

D. Provide a distribution panelboard suitable for distribution of the DC power supply. The panelboard shall be DC type sufficiently rated and shall include circuit breakers, thermal magnetic type rated as required for each circuit.

E. The quantity and function of circuit breakers required shall as shown on the Drawings. The battery and charger supply circuit breakers shall be equipped with auxiliary switches, two (2) breaker status contacts from each breaker, for remotely indicating that the disconnect is open.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Battery Room

1. The battery room shall be provided with a duty exhaust fan for exhausting the battery room air directly to the outside of the Electrical Building. The battery room exhaust fan shall be provided with a room mounted HOA switch and for automatic and manual control of the fan. This exhaust fan shall continuously run under normal circumstances. An alarm signal shall be sent to the remote circuit control panel/annunciator, and outdoor alarm horn if the duty battery room exhaust fan failed.

2. The battery room shall also be provided with a battery room emergency exhaust fan which shall start to run automatically if the duty exhaust fan fails. The battery room emergency fan shall be provided with a room mounted HOA switch for automatic and manual control of the fan.

3. The battery shall be installed in a custom-made enclosure. The enclosure shall be NEMA 12 rated. The battery room emergency exhaust fan shall be installed and operate as described in the Specification Section 26 13 26 – Medium-Voltage Metal-Clad Switchgear.

4. A battery room exhaust fan failed signal shall be sent to Medium-Voltage Metal-Clad Switchgear breaker remote control (mimic) panel to display and activate the common alarm and horn. The common alarm signal shall be sent out to a remote/outdoor/exterior horn/strobe.

5. The light switches and receptacles in the battery room shall be made of explosion proof materials.

6. Battery Room shall be vented as shown on the Contract Drawings to comply with NEC, NYS Building Codes, local codes, and Utility requirements.

B. Battery Racks

1. Each CBS shall be furnished and have installed racks to support all cells.

2. Racks shall be configured to fit into the CBS room as shown on the Contract Drawings.

3. Racks shall comprise steel vertical columns, cross braces, horizontal support rails and all accessories to form a support system which complies with the seismic requirements of the NYS Building Codes, and local codes. Battery racks shall be seismic braced suitable for Uniform Building Code, Zone 2A application. Battery racks shall be single- or two-tier steel with powder coated ANSI Gray #61 acid resistant epoxy paint.

4. Each support rail shall be insulated with plastic no less than 1/16 inch thick.

5. The batteries and rack shall be housed in a free-standing vented type cabinet. The cabinet shall be steel 12 gauge constructed and shall include key lockable front doors with lexan type windows. The cabinet shall be equipped with a cutout for vent fan ductwork connection and a door limit switch for activation of the emergency fan.

6. The battery rack shall be provided with a 4-inch deep, PVC type spill control barrier that extends two inches beyond the rack in all directions. A neutralizing and absorbing pillow shall be provided in each barrier.

7. Racks shall be grounded in conformance with the CBS system ground monitoring scheme as shown on the Contract Drawings.

C. Spill Containment

1. Each battery rack shall be provided with UL listed liquid-tight 4-inches deep spill containment system.

2. The spill containment system shall be provided by the CBS manufacturer.

3. The spill containment system shall extend at least one inch beyond the base of the battery rack in all directions.

   a. An approved mechanism to neutralize spilled electrolyte shall be provided.

   b. The neutralizing mechanism shall be capable of neutralizing the contents of two cells to a pH between 7.0 and 9.0 and consist of the following:

      1) Materials and equipment certified for use with flooded cells.

      2) Containment trays shall be acid resistant.

      3) Containment tray shall be minimum of a 4-inch deep.

      4) Containment tray shall be made of PVC material with a LOI of 28%.

      5) Each neutralizing and absorbing pillow shall be capable of absorbing and neutralizing the content of 4 cells.

D. Eyewash System

1. Eyewash system shall be installed as shown on the Contract Drawings outside of each CBS room.

2. Eye Wash system shall comply with the DEP Bureau BWS EHS requirements.

E. Painting

1. Racks shall be treated to resist deterioration from electrolyte and acid and shall have not less than two finish coats of acid resistant electrostatically applied epoxy ANSI 61 gray paint.

2. Finish coat shall be a minimum of 150 microns.

3. Field painting, other that touchup painting, shall not be required.

4. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

F. Nameplates conforming to Section 26 05 53 – Identification for Electrical Systems shall be provided for all components of each CBS installation.

1. Nameplates shall clearly indicate information in accordance with NEMA and IEEE requirements.

2. Nameplates shall be engraved or embossed on stainless steel.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. The CBS shall be completely assembled, wired, and tested at the factory, including all buses, connections, insulator, terminals, and terminal blocks, to demonstrate that it has been properly manufactured, properly assembled, is not overheating, is not overloading and has no electrical or mechanical defects.

2. Shop testing shall be performed on the CBS at the manufacturer's plant prior to shipment.

3. Shop test shall be in accordance with the latest revisions of IEEE 450 and NEMA PE5.

4. The Contractor shall provide a shop test report.

a. The report shall identify the tests performed and the results obtained.

5. Perform DC power system visual and mechanical inspection of all components and testing which at a minimum shall include the following:

a. Battery voltage and internal resistance testing

b. Charger voltage and current functionality and protection testing.

c. Charger dielectric and surge testing

d. Charger control and alarm simulation function testing.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. The Contractor shall install the CBS and associated equipment per the manufacturer's recommendations.

B. The battery racks shall be in concrete pads and bolted to the floor and shall comply with seismic requirements of NYSBC and local government requirement.

C. Batteries and rack assembly shall be arranged to provide easy access to each cell or module for maintenance and replacement.

D. The cables or the bus bars between cells, racks or modules shall be securely connected.

E. Each cell shall be uniquely identified and labelled.

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, CBS shall be field tested for operation and conformance.

B. Field testing shall conform to the requirements in this Section, IEEE 484, and the manufacturer's recommendations.

C. Perform field tests in accordance with the procedures and requirements set forth in this Section and the Specifications.

D. Field tests shall be witnessed by the Engineer and certified by the Contractor.

E. The following minimum tests shall be performed:

1. Visual and Mechanical Inspection

a. Verify all CBS equipment are located according to approved submittal.

b. Verify all nameplates, tags, and identification marks in accordance with approved submittal and preliminary Builts Drawings.

c. Verify CBS room ventilation is functions as per approved control strategies.

d. Verify adequacy of support racks, mounting, anchorage, alignment, grounding, and clearances.

e. Record electrolyte level of all cells

f. Measure and record specific gravity of each cell.

g. Measure and record the temperature of each cell.

h. Verify application of oxide inhibitor on all cell terminals and connections.

i. Verify battery charger cooling fans.

j. Inspect spill containment.

k. Verify functioning of eyewash and shower systems.

l. Verify cleanliness of equipment and that no leaks, cracked or marked jars exist.

2. Electrical and Capacity Tests

a. Batteries

1) Perform a freshening charge on the CBS batteries for at least seventy-two (72) hours or as recommended by the manufacturer.

2) Measure cell voltage and battery voltage under float and equalize conditions.

3) Measure and record inter-cell connection resistances.

4) Determine the internal resistance of all cells.

b. Charger

1) Verify, float, equalize and high voltage settings.

2) Verify current limit.

3) Verify accuracy of all readouts and indicators.

4) Measure charger float and equalize voltage and adjust to recommended settings.

5) Verify all charger functions and alarms.

6) Measure and record input and output current and voltage.

7) Measure and record ripple current and voltage of imposed on the battery.

8) Simulation of malfunctions to verify protective device operation and transfer of load CBSs where applicable.

9) Test output voltage as loading on the CBS is varied under the following conditions of operation such as:

a) Continuous, intermittent, and momentary each taken separately and together load.

b) Momentary peak load

10) Standby, reserve and battery power circuitry are complete and operate properly.

11) Output DC power supplies provide the correct voltage levels and correct polarity, record voltage and loads.

12) Ground fault detectors are operating correctly.

F. Manufacturer Services

1. A qualified manufacturer's service representative shall assist in the installation of the CBS, check the CBS installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the plant operations and maintenance staff in the care, operation. and maintenance of the batteries.

2. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site.

a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

3. The CBS manufacturer’s representative shall certify in writing to the Engineer that the CBS equipment has been installed, setup and tested properly in accordance with Contract requirements and is operating at optimum conditions and capacity.

4. The CBS manufacturer shall also make any necessary adjustments and instruct the Site personnel in its operation and maintenance.

5. The service representative shall sign in with the Engineer on each day they are at the site.

6. Manufacturer's Site Services – Minimum Days Required:

a. Multiple trips may be required due to construction scheduling and equipment start-up sequence.

b. Additional trips or days that are required to achieve the proper installation, operation or training, such services shall be arranged for by the Contractor at no additional cost to the City.

c. The following minimum services of the Manufacturer's representative shall be provided for the CBS:

Visit Type	Minimum Number of Visit(s)	Minimum Number of Person(s) per Visit	Minimum Number of Day(s)
Equipment Installation and Inspection	1	2	3
Field Tests	1	2	1
Acceptance Testing	1	2	1
Training	1	2	1

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide acceptance testing of the CBS.

B. All acceptance testing shall be performed by the testing firm, after the completion of the Field Test specified under in this Section.

C. Acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

D. Acceptance testing inspection shall be performed on the CBS.

E. All test data and values for each CBS shall be in accordance with the manufacturer's recommendations and NETA ATS.

F. The Contractor shall submit an acceptance testing report upon completion of inspection and testing.

1. The report shall be in accordance with NETA, ATS -Acceptance Testing Specification.

G. Training Services

1. Training services shall be provided by the battery manufacturer as specified herein and related sections.

2. The training shall cover the following minimum topics:

a. Basic battery theory

b. Theory of operation

c. Fault analysis and troubleshooting

d. Preventative maintenance procedures

3. The Contractor shall submit for approval by the Engineer, lesson plans identifying in detail, the training to be conducted.

4. The Contractor shall coordinate training services with the City and the Engineer.

5. The Contractor shall schedule training at least forty-five (45) days prior to delivery of training subject to the approval of the Engineer and the City.

6. The training shall consist of both classroom and field instruction.

7. The purpose of field instruction shall be to reinforce topics covered in the classroom and to identify the location of any control switches and other equipment required for operation; and to identify locations of any maintenance equipment.

8. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

9. The manufacturer's representative shall sign in and out at the office of the Resident representative on each day he is at the project site.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing uninterruptible power supplies (UPS). UPS shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The uninterruptible power supplies required under this Section shall be single or three phase, continuous on line, double conversion, solid-state types.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 27 - Grounding

B. Section 26 05 53 - Identification for Electrical Systems

C. Section 26 29 13 - Enclosed Controllers.

1.04 REFERENCES

A. Definitions

1. PWM – Pulse Width Modulated.

2. IGBT – Insulated Gate Bipolar Transistor

B. Reference Standards. UPS shall comply with the latest applicable provisions and recommendations of the following:

1.	ANSI C84.1	-	Electrical Power Systems and Equipment - Voltage Ratings.
2.	IEEE C62.41	-	Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
3.	IEEE C62.45	-	Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.
4.	NEC	-	National Electrical Code.
5.	UL 924	-	Emergency Lighting and Power Equipment
6.	UL 1449	-	Transient Voltage Surge Suppressors.
7.	UL 1778	-	Uninterruptible Power Supply Equipment.
8.	ASTM D178	-	Electrical Switchboard Matting.

1.05 DESCRIPTION

A. General

1. The UPS shall consist of convertor, an inverter, a precision float battery charger, a sealed, maintenance free battery and a bypass switch housed in self-contained compact package.

2. Each UPS shall provide the following operations:

a. Under normal conditions the critical load shall be continuously supplied by the inverter.

1) The inverter shall power the load while regulating both the voltage and the frequency.

2) The convertor shall derive power from the AC source and shall supply DC power to the inverter. Simultaneously, the batteries shall be charged.

b. When AC line power fails or goes out of tolerance, the battery source shall automatic supply the inverter via the DC link bus.

1) There shall be no break in the output to the load, voltage, or frequency during transfer from normal AC line supply to the battery supply or from the battery supply back to the AC line supply.

2) Upon restoration of the AC supply the battery charger shall automatically recommence charging the battery.

c. In the UPS position, the bypass switch shall connect the conditioned output to the load.

d. In the line position, the bypass switch shall cause the AC input line to be directly connected to the load.

e. Each UPS shall have active voltage regulation to enable the UPS to maintain its output voltage and frequency with varying input sources.

f. Each UPS shall be computer load compatible suitable for the demands of computer type loads including power factor corrected, switch-mode and linear power supplies.

g. Power ratings, nominal input and output voltages, phases and frequency shall be as shown on the Contract Drawings.

B. Operating Criteria:

1. The uninterruptible power supply's operating criteria shall be in accordance with the following:

a. Ambient temperature range - 0 degrees C to 40 degrees C.

b. Operational humidity – up to 95 percent non-condensing.

c. Maximum altitude - 3,000 feet above sea level

d. Altitude correction - 1-degree C per 1,000 feet.

e. Voltage regulation - plus or minus 3 percent with input voltages plus fifteen to minus twenty percent of nominal.

f. Overload capability

g. 150 percent surge and 125 percent for 10 minutes operating on line.

h. 150 percent surge and 110 percent on inverter.

i. Nominal frequency - 60 hertz

j. Adjustable tracking limits of .01 to 3 hertz.

k. THD – less than 5 percent at rated load.

l. Efficiency - 85 percent minimum.

C. Protection: The uninterruptible power supply shall have protective functions in accordance with the following.

1. Lightning and surge protection shall provide 2,000 to 1 spike attenuation.
2. Noise rejection shall provide common mode greater than 120 dB and normal mode greater than 60 dB.
3. Breakers shall provide over current protection for DC and battery charger circuits.
4. Remote emergency off shall shutdown the output supply to the load when activated from an external switch.

1.06 QUALITY ASSURANCE

A. General

1. The UPS shall be designed, built, and tested in accordance with the latest applicable editions of ANSI, IEEE, NEMA, UL, and NFPA.
2. The UPS shall be UL listed.
3. The UPS shall provide a reliable source of isolated, regulated uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power.
4. The UPS manufacturer shall have ten (10) or more years of experience in the design and be regularly engaged in manufacturing, and servicing equipment for installations of the type and size specified under this Section.
5. The UPS manufacturer shall use a shop test facility that has qualified, experienced technicians, for all shop tests.

B. Field Tests:

1. The UPS shall be field tested.
2. Field testing shall be performed in accordance with the requirements specified under this Section.
3. Retain the services of the UPS manufacturer for field service.
4. Field service shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Name of the proposed manufacturer and location of closest service office from which this equipment shall be serviced and location of closest parts inventory.
2. Manufacturer's catalog cuts and technical information required to demonstrate compliance with the specific requirements and to show all physical features and enclosure dimensions.
3. A completed materials list showing all items proposed for use.
4. Control and wiring diagrams with construction details of enclosures.
5. Single-line diagrams
6. Three-line diagrams.
7. Technical specifications.
8. Construction details of enclosures.
9. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least ninety (90) days in advance prior to conformation of witness testing dates and actual testing.
10. Qualifications of proposed testing firm to perform acceptance testing shall be submitted. Submit firm experience records at least ninety (90) days in advance to actual testing, five recent references with phone numbers shall be submitted.

B. Certificates of Compliance:

1. Seismic qualification certification from the manufacturer including mounting recommendations.
2. Cybersecurity Equipment Certification
3. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company. Upon approval, release for shipment to site shall proceed.

C. Reports:

1. Shop test and field test reports shall be submitted.
2. Manufacturer's site visit and acceptance testing reports shall be submitted.

D. Operation and maintenance

1. Operation and Maintenance manuals shall be submitted in accordance with this Section and the Specifications.

E. Bill of Materials

1.08 DELIVERY, STORAGE, AND HANDLING

A. The UPS equipment shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's recommendations and the following:

1. UPS equipment shall be inspected for shipping damage or loose parts when received.

2. Evidence of water which may have entered equipment during transit shall be checked.

3. UPS equipment shall be lifted, rolled, or jacked into locations shown on the Contract Drawings.

4. UPS equipment shall be stored in a clean, dry location in which a uniform temperature is maintained.

5. UPS equipment shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.

6. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the UPS/s in accordance with the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be furnished and shall include one set for every four systems installed per power rating. Each spare part set shall consist of the manufacturer's complete line of recommended spare parts inventory and shall include at a minimum the following:

1. One (1) set of fuses shall be provided of each size and type used.

2. One (1) set of boards including interface, connection, fuse, display, driver, power supply with accessories shall be provided.

3. One (1) set of modules including static switch assembly with accessories shall be provided.

4. One (1) set of current monitor boards and contactor including convertor, inverter, I/O and DC with accessories shall be provided.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. UPS/s shall be as manufactured by:

1. Schneider Electric;
2. Eaton;
3. Or approved equal.

B. Batteries shall be as manufactured by:

1. C&D Technologies Inc., Blue Bell, PA;
2. Schneider Electric;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. The UPS section shall comprise components organized in a modular manner to facilitate easy and ready replacement of components.

B. The mean time to repair of any module shall be thirty (30) minutes or less to return the UPS to its normal mode of operation.

C. Convertor module

1. The rectifier/charger shall convert the incoming AC power to a regulated DC output for supplying the inverter and for charging the battery.
2. The rectifier/charger shall be PWM design, using IGBTs.
3. The rectifier/charger module power factor under normal conditions shall be not less than 0.99.
4. The IGBTs shall feature protection circuitry that prevents the IBGTs from sourcing current in excess of their specified ratings.

D. Inverter module

1. The inverter shall comprise IBGT PWM design with high speed switching.
2. The inverter shall be capable of proving the required voltage and frequency while operating from the rectifier or the battery.
3. The IGBTs shall feature protection circuitry that prevents the IBGTs from sourcing current in excess of their specified ratings.

E. Static Bypass

1. The static bypass shall comprise fully rated, continuous duty, naturally commutated static switches and facilitating high speed transfers.

2. The static bypass shall feature the following:

   a. No break in output voltage and frequency.

   b. Transfers complete in less than 2 cycles.

   c. Transfers to bypass shall be automatically initiated for the following conditions:

      1) Output overload beyond the setting period time out.

      2) Bus voltage out of limits.

      3) Internal over temperature setting period time out.

      4) Battery approaching discharge

      5) Convertor or invertor failure

   d. Transfers to bypass shall be inhibited for the following conditions:

      1) Bypass voltage out of limits

      2) Bypass frequency out of limits

      3) Bypass out of synchronization

      4) Phase rotation error.

   e. Uninterrupted automatic re-transfers shall take place whenever the inverter is capable of assuming the load.

   f. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:

      1) When transfer is manually initiated.

      2) In the event of multiple transfer/retransfers cycles, the control circuit shall limit cycling to 3 cycles in any ten-minute period. At the end of the third transfer the control shall lock the load on bypass and initiate an alarm.

      3) Convertor or invertor failure.

F. Batteries

1. Batteries shall be enclosed in the UPS cabinet or a separate cabinet when necessary.

2. Batteries shall be sealed maintenance free lead-calcium types.

3. Batteries shall be capable of maintaining the 110% of the rated load for 2 hours. For the Police Booth, the battery autonomy shall not be less than 15 minutes.

4. Batteries shall be capable of a minimum of 200 complete full load discharge cycles when operated and maintained within Specifications.

5. A DC breaker shall provide protection for the batteries.

6. UPS shall be capable of monitoring and alarming an open DC breaker.

G. Controls and Indicators

1. Microprocessor controlled circuitry

a. Fully automatic control of the UPS shall be provided through the use of a microprocessor controlled operating control system.

b. Start-up and transfers shall be automatic functions and shall not require operator intervention.

2. Front Panel Display

a. The UPS control panel shall be a touch sensitive, backlit LCD front panel that includes LED indicators for basic UPS status. The LCD display shall a minimum be configured the following sections:

1) Home Screen

a) Show UPS status of output voltage, battery time remaining, and current alarms on all screens.

b) Show load level, average efficiency, and power consumption in kW.

c) Show a system mimic diagram or menu showing power path, operating mode, and active events.

2) Control Section

a) Provide touch sensitive control buttons with confirming prompt, to at minimum.

b) Turn UPS on or off.

c) Transfer to or from bypass.

d) Enable or disable the battery charger.

e) Initiate a battery test.

3) Metering Section

a) The metering section shall show voltages, currents, temperatures, kW, kVA and pf for the UPS input, output, and bypass.

4) Log Section

a) The log section shall show active alarms, alarm history, events, status changes and commands.

b) The period interval at which information is displayed shall be adjustable.

5) Settings Section

a) The settings section shall permit the adjustment of all ranges and discrete data points of the UPS such as

(1) Date and time

(2) Alarm designation

(3) Communications parameters

(4) UPS name

(5) Display language

(6) Passwords

3. Indicators

a. The colors for UPS alarm and event indicators shall be as follows:

1) Red – The power source is suppling power to the rectifier/charger and the inverter is powering the load.

2) Amber and Horn – An alarm condition has been detected.

3) Blue – The UPS has transferred and is in the bypass state.

4) Green – The power source has failed, and the UPS battery is supplying the inverter which in turn is powering the load.

H. Interface Panel

1. A signal and communication interface panel located behind protective covers shall be provided and equipped with the following:

a. 4 Form C dry contact capable of relaying alarm and status conditions either as NO or NC signals.

b. Auxiliary contacts from the DC breaker

c. One host USB connector.

d. One device USB connector

e. One RS 232 port

f. One Modbus port

I. Enclosure

1. Enclosures shall be provided in accordance with NEMA requirements as follows:

   a. For dry, dusty locations, enclosures shall meet NEMA 12 requirements.

   b. For wet and corrosive locations, enclosures shall meet NEMA 4X requirements.

   c. NEMA 4X enclosures shall be fabricated from 316 stainless steel.

   d. For hazardous locations, UPS power shall be fed through intrinsically safe barriers from non-hazardous locations.

2. UPSs shall be designed for forced air cooling.

3. Cooling air shall be drawn in through the front of the unit and exhausted through the top.

4. All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS.

J. Insulating Floor Mat

1. The Contractor shall furnish and install non-conductive floor mat in front of the Static Uninterruptible Power Supply to provide insulation for the workers.

2. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on each UPS at the manufacturer's plant prior to shipment.

2. Shop test shall be in accordance with the latest revisions of IEEE and ANSI and shall demonstrate that the equipment tested conforms to the requirements specified.

3. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

4. UPS shop tests shall include the following:

a. Physical inspection shall be performed including verification of tightness of all connections and connections of wiring harnesses to and from individual modules and boards.

b. Functional tests which shall be the manufacturer's standard and include the following:

1) Verification of the calibration of all UPS instrumentation

2) Verification of all alarm and protections settings

3) Verification of the operation of all modes of the UPS and the trouble-free switchover from one mode to the next.

4) A steady state load test verifying all input and output voltages, currents, frequency, and balance among the phases at 0, 50 and 100% load.

5) Monitoring current and voltage harmonics during the steady state load test and verification that harmonics are within stated limits.

6) A transient load response test to verify voltage, current and frequency remain with specified limits when load acceptance and rejection is varied as follows:

a) 0% to 50% to 0%

b) 25% to 75% to 25%

c) 50% to 100% to 50%

7) A battery-rundown test

B. Witnessed Shop Tests:

1. The Contractor shall perform Witnessed Shop Tests in accordance with this Section and the Specifications.

2. The Witnessed Shop Test shall not be scheduled before the approval of the Certified Shop Tests

3. For the Witnessed Shop Test, the Contractor shall perform all of the Certified Tests in the presence of the witnesses.

4. The Contractor shall provide a Shop Test Report. The report shall identify the tests performed and the results obtained.

5. UPSs shall not be shipped before the approval of the Witnessed Shop Test Report

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. UPS equipment shall be installed in accordance with manufacturer's instructions and recommendations.

B. UPS equipment shall be installed so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. UPS equipment shall be installed so that sufficient working space is provided for to ensure adequate ventilation and cooling.

D. Where applicable UPS equipment shall be installed on concrete pads at locations shown on the Contract Drawings.

E. Where applicable steel channels shall be provided for support of UPS equipment.

F. UPS equipment shall be securely mounted to mounting surface/s with anchor bolts.

G. Anchor UPS to satisfy the specified seismic requirements in accordance with the anchorage details.

H. Install nameplates for identification of switchgear equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, UPS shall be field tested for operation and conformance.
2. The Contractor shall perform field tests in accordance with this Section and Specifications.
3. The field tests shall be witnessed by the Engineer and certified by the Contractor.
4. UPS testing shall be performed by the manufacturer's representative, prior to energizing equipment.
5. Equipment shall not be energized without the permission of the Engineer.
6. The testing shall be in accordance with the recommendations of the manufacturer's representative and shall consist at a minimum of the following:
    a. Verification of the calibration of all UPS instrumentation
    b. Verification of all alarm and protections settings
    c. Verification of the operation of all modes of the UPS and the trouble free switchover from one mode to the next.

d. A steady state load test verifying all input and output voltages, currents, frequency, and balance among the phases at 0, 50 and 100% load.

e. Monitoring current and voltage harmonics during the steady state load test and verify that harmonics are within stated limits.

f. A transient load response test to verify voltage, current and frequency remain with specified limits when load acceptance and rejection is varied as follows:

1) 0% to 50% to 0%

2) 25% to 75% to 25%

3) 50% to 100% to 50%

g. A battery-rundown test

7. Infrared testing shall be performed once after initial energization of the UPS and a second time after full load has been applied continuously for twenty-four (24) hours.

B. Manufacturer's Field Services

1. The Contractor shall provide the services of a qualified manufacturer's service representative who shall adequately supervise and assist in the installation of the UPS, check the UPS installation before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the Contractor and the City's operations and maintenance staff in the care, operation, and maintenance of the UPS.

2. The Contractor shall provide UPS equipment start-up services and training in accordance with this Section, the Specifications, and the Contract Drawings and the following requirements:

a. Minimum number of manufacturer's representative site visits per UPS:

Visit Type	Minimum Number of Visits	Number of Person(s)	Minimum Number of Days
Equipment Installation and Inspection	1	5	2
Field Tests	1	3	2
Acceptance Testing	1	3	2
Training	1	3	2

3. Any additional time required to achieve a successful installation shall be at the expense of the Contractor.

4. The Engineer shall have the right to reallocate any unused person-days.

5. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

6. The service representative shall sign in and out with the Engineer on each day they are at the site. Person-days shall be understood to be the actual time spent at site and does not include travel to and from the site.

3.04 STARTUP / DEMONSTRATION

A. The Contractor shall provide UPS start-up services and Training in accordance with this Section and the Specifications.

B. Acceptance Testing

1. The Contractor shall provide acceptance testing of the UPS.

2. All acceptance testing shall be performed by the testing firm, after the completion of the field tests specified under this Section.

3. The acceptance testing shall be witnessed by the Engineer and certified by the Contractor.

4. Acceptance testing inspection shall be performed on each UPS. Inspection shall include the following:

a. Physical, electrical, and mechanical condition shall be inspected.

b. Proper anchorage, required area clearances, physical damage and proper alignment shall be checked.

c. Ventilating air passageways shall be inspected for blockage.

d. All connections shall be inspected for high resistance.

e. Electrical and mechanical interlock systems shall be checked for proper operation.

f. Insulators shall be inspected for evidence of damage or contamination.

g. Equipment shall be cleaned and lubricated as required.

5. Acceptance electrical testing shall be performed on each UPS. Facility load supplemented with load banks shall be used for the testing. Testing shall include the following:

a. Verification of the calibration of all UPS instrumentation

b. Verification of all alarm and protections settings

c. Verification of the operation of all modes of the UPS and the trouble free switchover from one mode to the next.

d. A steady state load test verifying all input and output voltages, currents, frequency, and balance among the phases at 0, 50, and 100% load.

e. Monitoring current and voltage harmonics during the steady state load test and verify that harmonics are within stated limits.

f. A transient load response test to verify voltage, current and frequency remain with specified limits when load acceptance and rejection is varied as follows:

1) 0% to 50% to 0%

2) 25% to 75% to 25%

3) 50% to 100% to 50%

g. A battery-rundown test

h. Infrared testing shall be performed once after initial energization of the UPS and a second time after full load has been applied continuously for twenty-four (24) hours.

6. All tests and values shall be in accordance with the manufacturer's recommendations and NETA ATS.

7. The Contractor shall provide an acceptance testing report. The report shall be in accordance with NETA ATS.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Power conditioners shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. Power conditioners required under this section shall be the constant voltage transformer type for regulation and conditioning of low voltage AC power circuits.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 – General Electrical Requirements

B. Section 26 05 27 – Grounding

C. Section 26 05 53 – Identification for Electrical Systems

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

2. All references to the Electric Utility or Utility shall mean Consolidated Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

1.	IEEE 1100	-	Recommended Practice for Powering and Grounding Electronic Equipment.
2.	IEEE C62.41	-	Recommended Practice On Surge Voltages In Low-Voltage AC Power Circuits
3.	IEEE C62.45	-	Guide On Surge Testing For Equipment Connected to Low-Voltage AC Power Circuits.
4.	UL Standard No. 1012	-	Power Units Other Than Class 2.
5.	UL Standard No. 1283	-	Electromagnetic Interference Filters
6.	UL Standard No. 1449	-	Transient Voltage Surge Suppressors.
7.	NEC	-	National Electrical Code.

1.05 DESCRIPTION

A. Power conditioners shall be rated for the power rating and nominal input and output voltages shown on the Contract Drawings.

B. Power conditioners shall deliver isolated, regulated, transient and noise free sinewave power for linear or non-linear, high crest factor, resistive and reactive type loads.

C. Each power conditioner shall be enclosed in a heavy gauge steel enclosure.

D. The enclosure shall have identifying nameplates in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems.

1.06 QUALITY ASSURANCE

A. Power conditioners shall be designed, built, and tested in accordance with the latest applicable editions of NEMA, ANSI/IEEE, UL and NFPA.

B. Power and conditioners shall be UL listed.

C. Power conditioner manufacturers shall have experience in the design and be regularly engaged in manufacturing, and servicing equipment for installations of the type and size specified under this Section.

D. Power conditioner manufacturers shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

E. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure each power filter and conditioner is designed, assembled and tested in accordance with the requirements specified.

F. Retain the services of the power conditioner manufacturers for field service.

G. Field service shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to:

1. Manufacturer's catalog cuts and technical information required to demonstrate compliance with this Section's requirements.

2. Wiring diagram with construction details of enclosure.

C. Certificates of Compliance:

1. Certified copies of power conditioner characteristics and all other data necessary for determining power conditioner performance shall be submitted.

2. Results of shop tests shall be certified.

a. When routine tests are made in conjunction with complete initial tests, unwitnessed results shall be certified, and copies shall be submitted.

b. Results shall be included for each test.

3. Data and results of witness tests shall be submitted with copies of certified initial tests, accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company.

4. Upon approval, release for shipment to site shall proceed and the Engineer shall be notified of the arrival date.

D. Reports:

1. Shop test and field test reports shall be submitted.

2. Manufacturer's site visit and acceptance testing reports shall be submitted.

E. Operation and Maintenance Manuals shall be submitted in accordance with the Specifications.

F. Bill of Materials

1.08 DELIVERY, STORAGE, AND HANDLING

A. Power and conditioners shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer's recommendations.

B. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Power conditioners shall be as manufactured by:

1. Sola, Boise, ID;

2. Controlled Power Company, Troy, MI;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Power conditioners shall have line voltage regulation to automatically regulate the output voltage to within plus or minus 3 percent with input voltage fluctuations of plus 10 percent to minus 20 percent of nominal at 100 percent load.

B. Voltage regulation shall be variable range type to obtain improved regulation when operating below 100 percent load.

C. The power conditioner shall return the output voltage to 95 percent of nominal level within two AC cycles and to 100 percent within three AC cycles when the output is taken from no load to full resistive load.

D. Voltage ride through capability of the power conditioner shall maintain output voltage regulation with a loss of input voltage for up to one AC cycle.

E. Load regulation of the conditioner shall automatically regulate the output voltage to within plus or minus 3 percent when load changes from no load to full resistive load.

F. The output voltage of the conditioner shall contain a maximum harmonic content of five percent with input voltage distortion of up to 40 percent.

G. The power conditioner shall suppress voltage spikes to levels in accordance with IEEE C62.41. Noise attenuation shall be 140 dB common mode, 60 dB transverse mode.

H. Operating efficiency of the conditioner shall be 95 percent minimum at full load.

I. The power conditioner shall include a ferroresonant, dry type, convection cooled, transformer.

1. The transformer's primary winding shall be electrically isolated from the secondary winding.

2. The core of the transformer shall be solidly grounded.

3. The transformer windings shall be copper with a class H insulation system. Temperature rise shall not exceed 150 degrees C over a 40 degree C ambient temperature.

4. Windings shall be vacuum impregnated with epoxy resin.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the power conditioners at the manufacturer's plant prior to shipment.

2. Shop tests shall include the manufacturer's standard tests and shall demonstrate quality assurance inspection and testing procedures for the equipment.

3. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Install power conditioners at locations shown on the Contract Drawings.

B. Install power conditioners adjacent to panels with proper grounding in accordance with the manufacturer's recommendations.

C. Install nameplates for identification of equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Manufacturer's Services

1. A qualified representative from the power conditioner manufacturer shall assist in the installation of the power conditioners, check the installation before it is placed into operation, observe, and assist initial operations and train the plant operations and maintenance staff in the care, operation, and maintenance of the power conditioners.
2. The Contractor shall provide power conditioner start-up services and training in accordance with the Specifications.
3. The Contractor shall provide a field report from the power conditioner filter manufacturer's representative for each visit to the site.
    a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, training, instruction, and all other pertinent information.
    b. The manufacturer's representative shall sign in with the Engineer on each day they are at the site.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing low-voltage open transition Automatic Transfer Switches (ATSs) including Bypass-Isolation Switches.

1. The Contractor shall provide all labor, materials, equipment and incidentals and is required to furnish and install ATSs including Bypass-Isolation Switches, complete and operational, as specified herein and as shown on the Contract Drawings.

2. Each ATS shall be provided in an enclosure.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 – General Electrical Requirements

B. Section 26 05 27 – Grounding

C. Section 25 05 29 – Hangers and Supports for Electrical Systems

D. Section 26 05 53 – Identification for Electrical Systems

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volts Class.

2. All references to the Electric Utility or Utility shall mean Consolidated Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

C. The ATSs shall comply with the latest applicable provisions and recommendations of the following:

1.	IEEE-446	-	Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
2.	ISO 9001	-	Quality management systems - Requirements.
3.	NEMA ICS 10 Part 1	–	Electromechanical AC Transfer Switch Equipment.
4.	NEMA ICS 10 Part 4	–	Guide to the Application of Low-Voltage Automatic Transfer Switch Equipment.
5.	NFPA 110	–	Emergency and Standby Power Systems
6.	NEC	-	National Electrical Code.
7.	UL 508	–	Industrial Control Equipment.
8.	UL 1008	-	Transfer Switch Equipment.
9.	ASTM D178	-	Electrical Switchboard Matting.

1.05 DESCRIPTION

A. ATSs shall be rated for the voltage, ampacity and number of poles as shown on the Contract Drawings.

B. Switches shall have 600-volt insulation on all parts in accordance with NEMA standards.

C. The current rating shall be a continuous when the switch is installed in a non-ventilated enclosure, and shall conform to NEMA temperature rise standards.

D. ATSs shall be rated based on all classes of loads, resistive, tungsten, ballast, and inductive loads.

E. ATs shall have a short circuit and withstand ratings as shown on the Contract Drawings and shall withstand the magnitude of fault current without welding of contacts.

F. ATSs shall include, but not be limited to the following:

1. ATS Mechanism permitting alternate connection to Source 1 or Source 2

2. Bypass-Isolation Switch permitting the complete isolation of the ATS mechanism from Source 1 or Source 2 and facilitating the continued powering of connected loads.

3. Control Panel

4. Enclosure

G. Source 1 and Source 2 shall be as shown on the Contract Drawings.

1.06 QUALITY ASSURANCE

A. ATSs shall comply with UL 1008 and NEMA ICS 10.

B. The ATS manufacturer shall use a shop test facility, for all factory tests, that has recently calibrated testing apparatus and qualified and experienced technicians.

1. Calibration of testing apparatus shall be within one (1) year.

C. The ATSs shall be field tested.

1. Field testing shall be performed in accordance with the requirements specified under this Section.

D. The services of the ATS manufacturer shall be retained for field service.

1. Field service shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval by the Engineer.

B. Submittals shall include, but not be limited to:

1. The proposed manufacturer along with the location of its closest service facility from which the ATSs shall be serviced and location of closest parts inventory.

2. Manufacturer’s catalog cuts and technical information required to demonstrate compliance with the specific requirements.

3. A completed materials list showing all items proposed for use.
4. Control and wiring diagrams.
5. Construction details of enclosures.
6. Description of shop and field-testing methods, procedures, and apparatus with calibration dates.
    a. Testing methods and procedures shall be submitted at least 60 days in advance prior to confirmation of witness testing dates and actual testing.
7. Qualifications of proposed testing firm to perform acceptance testing.
    a. Submit firm experience records and five (5) recent references with phone numbers, at least sixty (60) days in advance to actual testing.

C. Certificate of Compliance:
1. Seismic qualification certification from the manufacturer including mounting recommendations.
2. Data and results of witness tests accompanied by a certificate of authenticity sworn to before a notary public by an officer of the manufacturing company.

D. Reports:
1. Shop test and field test reports.
2. Manufacturer's site visit and acceptance testing reports.

E. Operation and Maintenance (O&M) Manuals

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver ATSs to ensure uninterrupted progress of the work.

B. Releases of ATSs for shipment shall occur only upon approval of data and results of witness test reports.

C. Ship, handle and protect ATSs in accordance with the Specifications.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for ATSs.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Spare parts shall be as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ATSs shall be as manufactured by:

1. ASCO, Florham Park, NJ
2. Russelectric, Hingham, MA.
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Power section:

1. The ATSs shall be an open transition switch of double throw construction whose operation in either direction shall be initiated by a reliable electrical mechanism that is momentarily energized and the switch mechanically held in its required position.
2. Designs are not acceptable, that utilize components of molded-case breakers, contactors, or parts thereof and which are not intended for continuous duty, repetitive switching or transfer between Source No. 1 and Source No. 2.
3. There shall be a direct mechanical coupling of Source 1 No. and Source No. 2 mechanisms to facilitate transfer switch operation in three cycles or less.
4. The Source No. 1 and Source No. 2 contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position or connection of both sources to the common load connection.
5. The mechanical interlocking shall be such that the switch is unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
6. The ATSs shall have sufficient arc interrupting capabilities for 60 cycles of operation between Source No. 1 and Source No. 2, which are 120 degrees out of phase at rated voltage, 600% of rated current at 0.50 power factor to ensure that there will be no current flow between the two isolated sources during switching.
7. The contact structure shall consist of a main current carrying silver alloy contact, with a minimum of 50% silver content.
8. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes.

9. Inspection of all switch components shall be possible from the front of the switch without the disassembly of operating linkages and without the disconnection of power conductors.

10. Maintenance of all switch components shall also be possible from the front of the switch with access to all components.

11. A manual handle shall be provided for maintenance purposes. The handle shall permit an operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

12. For ATSs installed in systems having ground fault protective devices, and wired so as to be designated as a separately derived system by the NEC and local codes, a 4th pole shall be provided. This additional pole shall isolate the Source No. 1 and Source No. 2 neutrals.

13. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients.

    a. Add-on or accessory poles that are not of identical construction and withstand capability of the phase poles are not acceptable.

14. The transfer switches shall have a minimum short circuit withstand rating as shown on the Contract Drawings or as required by short circuit studies but not less than 65 kA symmetrical.

B. Bypass-Isolation Switch

1. A double-throw bypass-isolation switch shall provide manual bypass of the load from either source and permit isolation of the automatic transfer switch from all sources and load power conductors. All main contacts shall be manually driven.

2. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door.

3. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts).

    a. The bypass handle shall have three operating modes: "Bypass to Source 1," "Automatic," and "Bypass to Source 2."

    b. The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated.

    c. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

4. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open."

   a. The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load.

   b. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

5. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

C. Controls:

1. Solid State Control System

   a. The control system for the ATS shall be solid state based and shall also contain all logic devices including control, voltage sensing, time delays and any auxiliary equipment required for to properly implement the functions detailed under this Section.

   b. Control system shall have a programmable microprocessor controller with keypad and LCD display.

2. The panel shall be shielded, and door mounted on the inside door of the switch enclosure.

3. All components shall be connected with a numbered wiring harness equipped with a disconnect plug that allows isolation of the control panel.

4. The solid-state panel controls shall include adjustable three phase under voltage setting on each of the two sources to provide the following sequence of operation:

   a. When the voltage of any phase of Source No. 1 is reduced to 80 percent of nominal voltage for a period of 1 second (fixed), the transfer switch shall be signaled to transfer to Source No. 2, after an adjustable time delay (0 -30 seconds).

   b. The transfer switch shall remain in the Source No. 2 position indefinitely. Should any phase of the Source No. 2 source be reduced to less than 80 percent of nominal voltage for a period of 1 second (fixed), the transfer switch shall be signaled to transfer to Source No. 1, after an adjustable time delay (0 -30 seconds), if the Source No. 1 is available for operation.

c. The option of automatic transfer from Source No. 2 to Source No.1 as soon as Source No. 1 is available for operation shall also be provided.

5. The transfer switches shall contain red indicating lights. The lights shall indicate switch position. The indicating lights shall be push-to-test, heavy-duty transformer LED type. Indicating light voltage shall be 12 Volts.

6. All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers, and accessories shall be readily front accessible.

7. The transfer switches shall contain door mounted transfer/re-transfer pushbuttons. It shall allow an operator to switch from Source No.1 to Source No.2 and from Source No.2 to Source No.1. Transfer between sources shall be immediate.

8. The ATSs shall have all necessary accessories as required to transmit the status and alarm signals to a designated overall System Control Panel remote from the ATS.

D. Auxiliary Power

1. Provisions for an external control power source to power the control panel when both sources are not available.

2. The takeoffs for external power sources shall be as shown on the Contract Drawings.

E. Enclosure:

1. The entire ATS shall be completely assembled within one enclosure. The enclosure shall be NEMA 12, painted gray, ANSI 61.

2. Terminal blocks shall be provided within the switch enclosure facilitate the connection of off enclosure signals and auxiliary power provisions.

a. Twenty (20%) percent spare terminals, two (2) minimum, shall be provided.

b. Terminals shall be lettered or numbered to conform to the wiring diagrams.

3. The wires within automatic transfer switch shall be neatly harnessed to prevent the door damaging the wires and to prevent the wires hampering the door operation. All wires shall have identification markers on each end.

4. The enclosure shall be provided with a thermostatically controlled strip heater to keep humidity and temperature within acceptable levels.

5. The enclosure shall have identifying nameplates in accordance with the requirements of Section 26 05 63 - Labeling and Identification.

F. Insulating Floor Mat

1. The Contractor shall furnish and install non-conductive floor mat in front of the Automatic Transfer Switches to provide insulation for the workers.

2. The insulated floor mat shall be at a minimum of Type-II, Class-2 and withstand the available current, voltage at equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting

1. The enclosure shall be painted gray, ANSI 61.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the ATSs at the manufacturer's plant prior to shipment.

2. Shop tests shall demonstrate that the equipment conforms to the requirements specified.

3. The tests shall include the manufacturer's standard tests and the following at a minimum.

a. Operational tests to ensure proper operation of the components and sequence of operation.

b. High potential test in accordance with NEMA standard.

4. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

B. Witness Shop Tests:

1. The Contractor shall perform witnessed shop tests in accordance with the Specifications and this Section.

2. Witnessed Shop Test shall at a minimum repeat all of the Certified Tests in the presence of the design Engineers.

3. The Contractor shall provide a witnessed shop test report. The report shall identify the tests performed and the results obtained.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. ATSs shall be installed in accordance with the Specifications, this Section and the manufacturer's instruction and recommendations.

B. ATSs shall be fully assembled with all required devices, wiring, nameplates, terminal blocks, and enclosures.

C. ATSs shall be rigidly and securely mounted to the building structure or to supporting devices, which are rigidly and securely supported to the building structure.

D. ATSs shall be installed with sides parallel or perpendicular to walls or equipment, in a neat and professional manner.

E. ATSs shall be installed such that door swing is not hampered.

F. ATSs shall be securely fastened in position with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work.

G. ATSs shall be grounded in accordance with NYCEC and local code requirements.

H. Install nameplates for identification of equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, ATSs shall be field tested for operation and conformance in presence of the Engineer.

2. The Contractor shall perform field testing in accordance with the Specifications, and as described in this Section.

3. ATS testing shall be performed by the manufacturer's representative, prior to energizing equipment. The testing shall be in accordance with the recommendations of the manufacturer and shall include the following at a minimum.

a. Mechanical and electrical components shall be inspected.

b. The switches shall be sequence operated to verify proper operation.

B. Manufacturer's Field Services

1. A qualified manufacturer's representative shall check the ATSs before it is placed into operation, assist in the performance of field tests, observe, and assist initial operations and train the plant operations and maintenance staff in the care, operation, and maintenance of the ATSs.

2. The Contractor shall provide equipment start-up services and training in accordance with the Specifications.

3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the Site.

a. The report shall include complete information on time, schedule, tasks performed, persons contacted, problems corrected, tests results, training, instruction, and all other pertinent information.

4. The service representative shall sign in and sign out with the Engineer on each day they are at the site.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing lightning protection of structures.

B. Lightning Protection Systems (LPS) for structures or buildings shall be provided in accordance with the requirements specified under this Section, the Specifications and the Contract Drawings.

C. The Contractor shall retain the services of a Certified LPS Installer.

D. The Certified LPS Installer shall furnish all labor, materials, equipment, services and incidentals necessary for the installation of a functional and complete LPS as specified herein.

E. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 26 05 27	-	Grounding
B.	Section 26 05 53	-	Identification for Electrical Circuits
C.	Section 26 23 23	-	Low-voltage Switchgear
D.	Section 26 24 16	-	Panelboards
E.	Section 26 43 13	-	Low-Voltage Surge Protective Devices.

1.04 REFERENCES

A. Definitions

1. Certified LPS Installer is a Subcontractor who is UL Master Labelled Certified Lightning Protection System Installer or Lightning Protection Institute Certified Installer
2. Certificate of Inspection where used in this Section shall mean UL Lightning Protection Master Label Certificate.
3. Letter of Findings where used in this Section shall mean an official UL report detailing inspection of a LPS with intentional noncompliance due to construction or limitations of scope outlined by the installer that render an LPS ineligible for a UL Lightning Protection Master Label Certificate.
4. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.
5. All references to the AHJ (Authority Having Jurisdiction) shall mean the NYCEC and Local Codes.
6. All references to the Electric Utility or Utility shall mean Consolidated Edison Company or the Local Electric Utility having jurisdiction.
7. LPI – Lightning Protection Institute.

B. Reference Standards

1.	LPI 175	-	Standard for the Design-Installation-Inspection of Lightning Protection Systems.
2.	NFPA 780	-	Standard for the Installation of Lightning Protection Systems
3.	NEC	-	National Electrical Code.
4.	UL 96	-	Standard for Lightning Components.
5.	UL 96A	-	Standard for Installation Requirements for Lightning Protection Systems.
6.	UL 467	-	Grounding and Bonding Equipment

7.	UL 651	-	Schedule 40, 80, Type EG and A Rigid PVC Conduit and Fittings.
8.	UL LPS Guide	-	UL Marking and Application Guide – Lightning Protection.
9.	ANSI/IEEE 141	-	Recommended Practice for Electric Power Distribution for Industrial Plants.
10.	IEEE 1100	-	Recommended Practice for Powering and Grounding Electronic Equipment.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Installer

1. The LPS Installer shall be a Certified LPS Installer.
2. Provide proof of the certification, or demonstrate that the standards and experience required for certification are possessed, all to the satisfaction of the Engineer.

B. Materials

1. All materials shall be new and shall comply in weight, size and composition as required by UL 96A and NFPA 780 and for the structures or building to be protected.
2. Class I materials shall be used for systems on structures not exceeding 75 feet in height.
3. Class II materials shall be used for systems on structures exceeding 75 feet above grade.
4. All materials used in the installation shall be labeled or listed by UL for use in LPSs
5. All materials shall be of copper and high copper-content bronze castings or stainless steel.
6. LPS materials shall be selected to ensure that electrolytic or galvanic action does not occur at the contact points or surfaces.
7. Where dissimilar metals are in contact care must be taken to ensure that bimetallic connecting accessories are used and permit only similar metals to be in contact.

C. Certification of the Installation

1. The Engineer shall be given 96 hours' notice of the intent to cover or conceal all parts of the LPS which will not be visible after completion and turn over of the installation.
2. The completed system shall be in accordance with UL 96A and NFPA 780 or LPI 175 but not both.

3. A Certificate of Inspection shall be provided for the completed LPS.
4. For installation areas, where a Certificate of Inspection is not available, a Letter of Finding shall be obtained.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer.

B. Submittals shall include, but not be limited to:

1. Qualifications of proposed Certified LPS Installer.
   a. Submit experience records at least forty-five (45) days in advance to equipment submittals.
   b. Five (5) recent references with phone numbers shall be submitted.
2. Manufacturer's catalog cuts and technical information for the LPS materials proposed for use in this Contract.
   a. Submittals shall demonstrate the mechanism that will be used to isolate dissimilar materials.
3. Scaled Shop Drawings showing proposed routing and layout of the LPS with installation details. Drawings shall include the stamp of the Certified Installer- Designer responsible for the system design.
4. Photographic and video documentation to show how the LPSs were installed in-ground and all concealed portions of the installation.

C. Certificates of Compliance:

1. Certificate of Inspection or Letter of Finding shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Lightning protection system materials shall be delivered, stored and handled in accordance with the manufacture's recommendations and this Section.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The lightning protection system shall be as manufactured by:

1. Heary Brothers Lightning Protection Company, Springville, NY.
2. Thompson Lightning Protection Company, West St Paul, MN.

3. East Coast Lightning Equipment, Winsted, CT.
4. Pentair Erico, Solon, OH
5. Or approved equal.

B. Non-metallic conduit and fittings shall be by as manufactured by:

1. Carlon (Thomas and Betts) - Memphis, TN.
2. Cantex Inc., Fort Worth, TX
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. All materials used in the installation shall be new and shall comply in weight, size and composition as required by UL 96A and NFPA 780

B. All lightning protection system fittings shall be heavy duty type.

C. All bolts, screws and hardware shall be stainless steel.

D. Air Terminals and Accessories

1. Air terminals shall be not less than 18 inches long, not less than 5/8-inch in diameter and may be manufactured in separate parts if longer than 10 inches.
2. Air terminals shall include a cast bronze point protector, stainless steel adapter and copper base.
3. Air terminals shall be provided with an integral base support, or shall have not less than five full threads of engagement with a separate attachment base mounted to the structure.
4. If the air terminal has internal threads the wall thickness shall be not less than 1/16 inch at the base of the threads.
5. Air terminals longer than 24 inches shall have bracing at half its height and listed for the purpose
6. Air terminal bases are permitted to be stamped or cast construction.
   a. Copper bases shall 0.061 minimum for copper material. If cast either copper or aluminum shall be at least 3/32 inches thick.
   b. Air terminal base support must incorporate a connector fitting for connection of the lightning conductor.
      1) The conductor contact area must be at least 1-1/2 inches on all sides of the cable

E. Conductors

1. Class I
   a. Main conductors shall be stranded copper conductors and shall be at least 57,400 circular mils at 187 lbs per 1000 ft.

b. Secondary or bonding conductors minimum size shall be 26,240 cir. mils for copper.

2. Class II

a. Main conductors; shall be not less than 115,000 cir. mils for copper conductor at 375 lbs per 1000 ft.

b. Secondary or bonding conductors minimum size shall be 26,240 cir. mils for copper.

F. Grounding Electrodes

1. Ground rod electrodes shall be copper-clad steel, a minimum 5/8" diameter and 10 feet long.

2. Ground rods shall conform to the requirements of Section 26 05 27 - Grounding.

G. Ground Cables:

1. Ground cables shall be copper or aluminum where necessary to prevent dissimilar metal reaction.

2. Ground cable stranding, number and size shall be suitable for the classification of the structure to be protected.

3. All ground cable where exposed shall be corrosion resistant.

H. Non-metallic conduit shall be schedule 80 PVC plastic, 90 degrees C rated, conforming to UL No. 651.

I. Non-metallic fittings shall be of same material and manufacturer as base conduit. Cement shall be provided for joining fittings to the conduit and shall be the same manufacturer as the base conduit.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Air Terminals and Air Terminal Accessories

1. Air terminals shall extend a minimum of ten inches above the object or area they are to protect.

2. Air terminals shall be located at intervals not exceeding 20'-0" along ridges of pitched roofs and along the perimeter of flat or gently sloping

roofs (flat or gently sloping roofs include roofs that have a pitch less than 3:12).

3. Flat or gently sloping roofs exceeding 50'-0" in width shall be provided with additional air terminals located at intervals not exceeding 50 feet.

4. Air terminals shall be located within two feet of the ends of ridges, roof edges and outside corners of protected areas.

5. Air terminals shall be installed on stacks, flues, mechanical units and other objects not located within a zone of protection.

6. Permanent metal objects on the structure having an exposed metal thickness 3/16" or greater may be substituted for air terminals and shall connected to the lightning protection system as required by the specified standards using main size conductor and bonding plates having a minimum of 3 square inches of surface contact area.

7. Air terminal bases shall be securely fastened to the structure in accordance with the specified standards.

   a. Fasteners may include stainless steel screws, bolts, nails or anchors.

   b. Adhesives shall only be used to complete other types of fasteners and shall be compatible with the fastener and structure material

   c. Any protective sheets or pads that may be required by the roofing system manufacturer shall be furnished and installed by the Contractor.

8. Air terminal spacing exceeding these dimensions, shall be permitted so long as the area protected lies within a zone of protection.

9. Air terminals shall be installed for stacks, flues, mechanical equipment, and other objects, having a metal thickness of less than 3/16 of an inch, and not located within a zone of protection.

   a. Permanent metal objects having a metal thickness 3/16 of an inch or greater shall be connected to the LPS in lieu of air terminals by main size conductors and bonding plates having a minimum of 3 square inches of surface contact area.

10. Flat or gently sloping roofs exceeding 50 feet in width, shall be protected with additional air terminals located at intervals not exceeding 50 feet in the flat or gently sloping area.

B. Conductors and Accessories

1. Conductors shall provide a two way, horizontal or downward path from each strike or air terminal to connections to the lightning protection ground electrode system.

2. Down conductors shall be sized as Class I or Class II materials in accordance with the specified standards.

   a. Down conductors where required as shown on the Contract Drawings shall be concealed in the exterior wall construction.

b. Class II conductors from a higher portion of a structure shall continue to connections to the lightning protection ground electrode system.

c. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure.

d. In no case shall a structure have fewer than two down conductors.

e. Where down conductors are installed exposed on the exterior of a structure and are subject to physical damage or displacement, guards shall be used to protect the conductor a minimum of six (6) feet above grade.

f. Metallic guards shall be bonded at each end.

3. In the case of structural steel frame construction, down conductors may be omitted and roof conductors shall be connected to the structural steel frame at intervals averaging not more than one-hundred (100) feet around the perimeter of the structure.

a. Connections to the steel frame shall be made with bonding plates having area of a minimum of 8 square inches.

4. Conductors shall be installed free of excessive splices and sharp bends.

5. Conductor bends shall form an included angle of not less than 90 degrees nor have a radius of bend of less than 8 inches.

6. Conductors shall be secured to the structure at intervals not exceeding 3 feet.

a. Fasteners shall be of the same material or of a material equally resistant to corrosion as that of the conductor.

b. Any protective sheets or pads that may be required by the roofing system shall be furnished and installed by the Contractor.

7. Connector fittings shall be listed for the purpose and of the same material as the conductor or of electrolytically compatible materials.

C. Ground Electrodes and Accessories

1. Each down conductor shall terminate at a ground electrode dedicated to the LPS, or to a building or facility ground electrode system that consists of multiple ground electrodes that are interconnected with a ground ring conductor.

2. The down conductor shall be connected to the ground electrode by as exothermically welded connection.

3. Ground rod electrodes shall be located a minimum of 2 feet below grade and shall be installed below the frost line where possible (excluding shallow topsoil conditions).

4. Where it is not possible to drive ground rod electrodes because of bedrock or shallow topsoil conditions, ground plate electrodes, radial electrodes,

ground ring electrodes, concrete- encased electrodes, or combinations of these may be used in accordance with NFPA 780.

5. Where the structural steel framework is utilized as down conductors for the system, ground electrodes shall be connected to columns around the perimeter of the structure at intervals averaging not more than 60 feet apart.

   a. The grounding connection at the columns shall be made using either bonding plates having 8 square inches of surface contact area or by exothermically welded connections.

D. Common Bonding of Grounded Systems

1. Common bonding of all grounded systems within the building shall be ensured by interconnecting them to the LPS using main size conductor and fittings.

2. For structures exceeding sixty (60) feet in height, the interconnection of the LPS ground electrodes and other grounded systems shall be in the form of a ground loop conductor.

3. These grounded systems to be interconnected shall include but are not limited to the electrical service, communication, and antenna system grounds as well as all underground metallic piping systems including water, gas, sewer, underground metallic conduits, etc.

4. Interconnection to service lines or conduits shall be made on the customer's side of the meter.

5. Ground Electrodes in test wells shall be bonded to the ground system by a bronze ground rod clamp having at least 1-1/2 inches of contact between the rod and the conductor, measured parallel to the axis of the rod.

6. The system shall be installed with common grounding by interconnecting ground mediums entering the building using main size conductors and fittings. Grounded metal bodies shall be bonded to the system using bonding connections and fittings. Ground conductors shall be installed in conduit, shall be non - metallic type.

E. Potential Equalization

1. Grounded metal bodies located within the required bonding distance as determined by the bonding distance formula in NFPA780 shall be bonded to the LPS using the required bonding conductors and connections.

F. Roof Penetrations

1. Roof penetrations required for down conductors or for connection to structural steel framework shall be made using thru-roof assemblies with solid riser bars or conduits and appropriate roof flashing.

2. Conductors shall not pass directly through the roof.

   a. The Contractor shall furnish and install the materials required to properly seal all roof penetrations of the LPS components and any additional roofing materials or preparations required by the roofing

manufacturer for lightning conductor runs to assure compatibility with the warranty for the roof including roof pads that may be required to protect the roof under each of the lightning protection components.

G. Surge Protective Devices (SPD)

1. SPDs shall be provided at all power services entrances and at entrances of conductive signal and data communication devices.

2. SPDs shall comply with Section 26 43 13 – Low-Voltage Surge Protective Devices.

3.03 FIELD TESTING / QUALITY CONTROL

A. The Contractor shall have the master installer or inspector perform field inspection of the lightning protection system at several stages during the installation in accordance with LPI requirements.

B. Upon completion of the lightning protection system the Contractor shall arrange for a final inspection of the system. The final inspection shall be performed by the master installer or inspector in accordance with LPI requirements.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing Surge Protective Devices (SPDs).

B. SPDs shall be provided in accordance with the requirements specified under this Section and the Contract Drawings.

C. SPDs shall utilized to limit repetitive transient voltage and current surges in low-voltage AC power circuits.

D. The Contractor shall furnish all labor, materials, equipment, services, and incidentals necessary for the installation of the SPDs as specified herein.

E. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 53 - Identification for Electrical Circuits

B. Section 26 05 27 - Grounding

C. Section 26 23 23 - Low-Voltage Switchgear

D. Section 26 24 16 - Panelboards

1.04 REFERENCES

A. Definitions

1. Low-voltage as used in this Section and the Specifications shall mean all equipment, conductors, insulation systems and accessories intended for operation within the 600 Volt Class.

2. All references to the AHJ (Authority Having Jurisdiction) shall be as set all local, state, and national approval agencies.

3. All references to the Electric Utility or Utility shall mean Consolidated Edison Company or the Local Electric Utility having jurisdiction.

B. Reference Standards

1.	ANSI/IEEE C84.1	–	Electric Power Systems and Equipment – Voltage Ranges (60 Hertz).
2.	ANSI/IEEE 141	-	Recommended Practice for Electric Power Distribution for Industrial Plants.
3.	IEEE 1100	-	Recommended Practice for Powering and Grounding Electronic Equipment.
4.	IEEE C62.41	-	Recommended Practice on Surge Voltages In Low-Voltage AC Power Circuits.
5.	IEEE C62.45	-	Recommended Practice On Surge Testing For Equipment Connected to Low-Voltage AC Power Circuits.
6.	IEEE C62.62	-	Test Specifications for Surge-Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low-Voltage (1000 V and Less) AC Power Circuits.
7.	IEEE C62.72	-	Guide for the Application of Surge Protective Devices for Low Voltage AC Power Circuits.
8.	UL 1012	-	Power Units Other Than Class 2.
9.	UL 1283	-	Electromagnetic Interference Filters

10.	UL 1449	-	Surge Protective Devices 4th Edition or later.
11.	NEC	-	National Electrical Code.

1.05 DESCRIPTION

A. SPDs shall be Type 1, 2 or 3.as defined by UL 1449.

1. Type 1 SPDs shall be:

a. Permanently connected and intended for installation between the secondary of the service transformer and the line side of service equipment.

b. Installed without use of external overcurrent protective device.

2. Type 2 SPDs shall be:

a. Permanently connected and intended for installation on the load side of the service equipment overcurrent device.

3. Type 3 SPDs shall be:

a. Permanently installed at the point of utilization.

b. Installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel.

c. Not used at the utilization point if the distance criteria of a. and b. above cannot be satisfied.

1.06 QUALITY ASSURANCE

A. SPDs shall be designed, built, and tested in accordance with the latest applicable editions of NEMA, ANSI/IEEE, UL and NFPA.

B. SPDs shall be UL listed.

C. SPDs of the types and ratings required are of those acceptable manufacturers who have been regularly engaged in the development, design, testing, listing, manufacture and servicing of SPDs for a period of ten years or more and whose products have been in satisfactory use for ten (10) years or more.

D. SPD manufacturers shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

E. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensure each SPD is designed, assembled and tested in accordance with the requirements specified herein.

F. Testing shall be done in accordance with UL 1449 on the complete SPDs with lead length comparable to that which will be required to connect the SPDs to the equipment to be protected and as shown on the Contract Drawings.

G. Only qualified personnel or licensed electricians shall actually install SPDs.

H. The Contractor shall retain the services of the SPD manufacturer for field service.

I. Field service shall be in accordance with the requirements specified under this Section and the Specifications.

1.07 SUBMITTALS

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer.

1. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory installation and operation.

2. Catalog cuts indicating selected ratings and mechanical drawings of SPDs, shall be submitted for approval by the Engineer.

3. Submittals shall contain the required published device specifications and Drawings to show conformance with all parts of this Section.

4. Instructions for installation and connection shall be provided with the SPDs.

5. All Let-Through voltage data shall be measured on an "As Installed" lead length basis, simulating actual installation. At the module or at the bus "Zero lead length" data is not acceptable.

6. Copy of the ISO 9001:2021 Certificate of Registration will accompany the submittal.

7. The connection lead length from the SPD enclosure to the connection point of protected circuit must be detailed in the submitted documentation.

B. Report Submittals:

1. Surge Protective Device (SPD) shop test reports shall include test data verifying let-through voltage, surge current rating and noise attenuation.

2. Manufacturer’s field report

3. Surge Life (Repetitive Surge) rating

4. Maximum Continuous Operating Voltage (MCOV) rating

5. Voltage Protection Ratings for all modes (VPR)

6. Nominal Discharge Current (In)

C. Operation and Maintenance (O&M) manuals shall be submitted for approval.

1.08 DELIVERY, STORAGE, AND HANDLING

A. SPDs shall be delivered, stored, and handled in accordance with the Specifications and the manufacturer’s recommendations.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. SPDs shall be as manufactured by:

1. Schneider, Seneca, SC;
2. Siemens, Washington, DC;
3. ABB, New Berlin WI;
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Electrical Requirements

1. The SPD operating voltage and configuration shall be as shown on the Drawings.
2. The Maximum Continuous Operating Voltage (MCOV) shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels.
    a. Each thermally protected MOV shall have an end-of-life indicator and the suppression system shall be continuously self-monitoring.
    b. End of life mode to be open circuit.
    c. SPDs with end of life short-circuit mode are not acceptable.
    d. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. SPDs must not require external OCPD or replaceable internal OCPD for the UL Listing.
5. The SPD must protect all modes of the electrical system being utilized, i.e. Normal (L-L, L-N) and Common (N-G, L-G).
6. The Nominal Discharge Current (I_n) for all SPDS shall not be less 20 kA regardless of Type.

7. The Voltage Protection Rating (VPR) of the SPDs shall not exceed the following:

Mode	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. Features

1. Balanced Suppression Platform

   a. Surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance.

   b. The surge suppression platform must provide equal impedance paths to each matched MOV.

   c. SPDs containing items such as single-mode replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted.

2. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

3. Each thermally protected MOV shall have an end of life indicator and the suppression system shall be continuously self-monitoring.

4. SPDs with removable covers or doors shall be equipped with internal safety barriers having lockout provisions to prevent contact with energized components.

5. Internal Connections

   a. No plug-in single-mode modules or printed circuit boards shall be used as surge current conductors.

   b. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

6. Electrical Noise Filter

   a. Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter.

   b. Noise attenuation for electric line noise shall be 50 dB or 40 dB minimum from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable to meet this specification shall not be accepted.

   c. Type 2 units with filtering shall be co-listed to UL 1283 5th Edition or later.

   d. Type 1 units shall not contain filtering nor can they have a UL 1283 5th Edition Listing.

7. Monitoring and Diagnostics

   a. Protection Status Indicator

      1) Each SPD shall have a green/red solid-state indicator lights that reports the status of the protection on each phase.

         a) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes.

         b) Wye configured units shall also contain solid-state indicator lights that report the status of the protection elements and circuitry in the N-G mode.

         c) SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

         d) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

         e) The absence of a green light and the presence of a red/yellow light shall indicate that damage has occurred on the respective phase or mode.

         f) All protection status indicators must indicate the actual status of the protection on each phase or mode.

         g) If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes.

         h) Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

   b. Remote Status Monitor

      1) SPDs, where shown on the Contract Drawings, must include Form C dry contacts (one NO and one NC) for remote annunciation of SPD status.

      2) Both the NO and NC contacts shall change state under any fault condition.

   c. Audible Alarm

      1) SPDs shall contain an audible alarm that will be activated under any fault condition.

      2) There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter

1) SPDs shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location.

2) The surge counter shall register a count for each surge event clamped by the SPD.

3) A reset pushbutton shall also be standard, allowing the surge counter to be zeroed.

4) In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

5) If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored.

6) The surge counter's memory shall not require a backup battery in order to achieve this functionality.

8. Metal Oxide Varistor Protection

a. SPDs shall contain thermally protected MOVs.

b. The self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV.

c. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

d. Each thermally protected MOV shall have an end of life indicator and the suppression system shall be continuously self-monitoring.

9. Overcurrent Protection

a. The unit shall not require external overcurrent protective device (OCPD) as part of the UL 1449 listing.

b. If the AHJ requires overcurrent protection of the conductors connecting the SPD to the system then OCPD shall be sized based on governing AHJ electrical code requirements.

10. Fully Integrated Component Design

a. All of the SPD's components and diagnostics shall be contained within one discrete assembly.

b. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

11. Safety Requirements

a. The SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable/replaceable parts and shall not require periodic maintenance.

b. SPDs containing items such as replaceable single-mode plug in modules, replaceable fuses, or replaceable batteries shall not be accepted.

c. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device can pose a safety hazard and shall not be accepted.

d. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit or shall have barriers that block access to harmful voltages.

e. Lockout provisions, capable of accepting a padlock, shall be provided on units with a disconnecting internal breaker if applicable.

f. SPDs without barriers or lockout provisions shall be factory sealed to reduce exposure to harmful voltages.

g. Factory sealed units shall have installed phase, neutral, ground and remote status contact conductors and shall have a pigtail set of conductors protruding outside of the enclosure for field installation.

12. The manufacturer shall certify that all materials and processes used as a component of the SPD units, and used in the process of manufacturing and packaging of the units are in accordance with The Federal Clean Air Act Amendments of 1990, Sections 602 and 611, prohibiting the use of Class I or Class II ozone depleting chemicals.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. SPDs shall have either NEMA 1, NEMA 4, or NEMA 4X stainless steel enclosures suitable for locations indicated on the drawings and as described below:

1. NEMA 1

a. Constructed of ANSI 61 painted steel.

2. NEMA 4

a. Constructed of ANSI 61 painted .

3. NEMA 4X

a. Constructed of 304 stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection.

4. NEMA 4X

a. Constructed of polycarbonate providing the same level of protection as the NEMA 4 enclosure.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Certified Shop Tests:

1. Shop testing shall be performed on the SPD at the manufacturer's plant prior to shipment.

2. Shop tests shall include the manufacturer's standard tests and shall demonstrate quality assurance inspection and testing procedures for the equipment.

3. The Contractor shall provide a shop test report. The report shall identify the tests performed and the results obtained.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. SPDs of the appropriate listing shall be installed at locations shown on the Contract Drawings

B. Installation locations shall include Service Entrance Equipment, Distribution Equipment and Utilization Equipment.

C. SPD installations shall confirm to the manufacturer's written instructions and recognized installation practices including:

1. Proximity to the protected equipment

2. Strict adherence to the total length of conductors feeding the SPD.

3. Minimum bend radius of feed conductors.

4. Maximum number of bends in the feed conductors.

5. Whether the grounded conductor is to be bonded at the SPD.

6. Grounding of both the SPD and the protected equipment.

D. The SPD manufacturer shall make available experienced, qualified, power-quality application and field supervision engineering services during installation and start-up.

E. The Contractor shall verify the proper application of the SPDs (i.e. voltage, phase, etc.) and coordinate with upstream and downstream SPDs.

F. The Contractor shall assure that all neutral conductors are bonded to the system ground at the service entrance or at separately derived system point, prior to installation of the associated SPDs.

G. Install nameplates for identification of equipment.

3.03 FIELD TESTING / QUALITY CONTROL

A. Manufacturer's Representative

1. A qualified representative from the SPD manufacturer shall assist in the installation of the SPDs, check the installation before it is placed into operation, observe and assist initial operations and train operations and maintenance staff in the care, operation and maintenance of the SPDs.

2. The service representative shall sign in with the Engineer on each day they are at the site.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing lighting fixtures (luminaires) and devices. Luminaires and devices shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

B. The lighting system shall be complete and include all equipment, devices and accessories as required for the installation of the luminaires and devices.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 26 05 20	-	Low-Voltage Wires, Cables and Accessories
B.	Section 26 05 27	-	Grounding
C.	Section 26 05 29	-	Hangers and Supports for Electrical Systems
D.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems
E.	Section 26 05 53	-	Identification for Electrical Systems

1.04 REFERENCES

A. Definitions

1. Not used

B. Reference Standards

C. Luminaires and devices shall comply with the latest applicable provisions and recommendations of the following even if not specifically listed in this Section:

1.	ANSI C78.377	-	Specifications for the Chromaticity of Solid-State Lighting (SSL) Products
2.	DLC PR	-	Design Lights Consortium Premium Technical Requirements
3.	EISA 2007	-	Energy Independence and Security Act of 2007
4.	IES LM-79	-	Approved Method: Electrical and Photometric Measurements of Sold State Lighting Products
5.	IES LM-80	-	Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
6.	IES TM-21	-	Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources
7.	NEMA SSL-1	-	Electronic Drivers for LED Devices, Arrays, or Systems.
8.	NEC	-	National Electrical Code.

9.	NYCECC	-	New York City Energy Conservation Code
10.	UL 20	-	General Use Snap Switches.
11.	UL 844	-	Electric Lighting Fixtures for Use in Hazardous Locations.
12.	UL 894	-	Switches for Use in Hazardous Locations.
13.	UL 924	-	Emergency Lighting and Power Equipment.
14.	UL 1010	-	Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.
15.	UL 1598	-	Luminaires
16.	UL 8750	-	Light Emitting Diode (LED) Equipment for Use in Lighting Products.
17.	CBM	-	Certified Ballast Manufacturers, CBM.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. General:

1. Luminaires shall be UL listed, approved for use in the City of New York and comply with NYCECC.

2. The luminaire types are noted within the fixture schedule which is shown in the Contract Drawings. The descriptions and catalog numbers serve to establish the quality, appearance, and performance of the specified luminaires.

3. Luminaires and controls shall be as manufactured by the same manufacturer.

4. All luminaires shall be the products of lighting equipment manufacturers who have previously demonstrated, by performance and reputation, the ability to manufacture products of the quality specified and shall have a minimum of five (5) years' experience manufacturing the luminaires specified. Such manufacturers must maintain an organization and manufacturing facility capable of actually manufacturing the specified

luminaires. For the purpose of inspection, Contractor shall assure the Engineer, free and easy access to the manufacturing facilities and inventories of any manufacturer whose equipment the Contractor proposes to supply.

5. Luminaries over the range of operating voltage and temperature shall comply with the following:
   a. Minimum power factor of 0.95
   b. THD for both current and voltage of less than 10%
6. Luminaries shall have integral UL Listed Class 2 drivers and ballasts.
7. Luminaires shall have integral surge protective devices (SPD) to protect the luminaire from common mode transient peak voltages and transient peak currents.
8. Luminaires shall comply with DLC PR.
9. Luminaires utilizing incandescent sources are not permitted.
10. Luminaires shall utilize electronic or solid-state drivers or ballasts where applicable.
11. The Contractor shall be responsible to assure that the exact inscription for exit and stairway signs required by local code is checked against that specified, prior to providing same. The Engineer shall be advised of any changes required to conform to local codes before such changes are affected.
12. The Contractor shall be responsible for reviewing all Contract Drawings and coordinating with all trades the installation of luminaires and devices. Luminaire and device finish and construction shall be compatible with the approved wall and ceiling types which shall be determined by the Contractor's review of all Contract Drawings.
13. All luminaires shall be of the highest quality material and construction for their respective types.
14. Lamps for all luminaires shall be in accordance with EISA 2007.
15. Luminaires shall be suitable for connection to concealed or exposed conduit runs as required in each particular location and shall be of sizes suitable for lamp sizes indicated on the Contract Drawings.
16. Fittings and other materials for special luminaires not definitely shown or specified shall be of approved material, make and quality and shall have a finish that will harmonize with other parts of the luminaires. Where suitable

standard materials are not available such parts of the luminaires shall be specially manufactured.

B. Field Testing:

1. Luminaires shall be field tested. The field testing shall be performed in accordance with the requirements specified under this Section.

2. Retain the services of the emergency inverter system manufacturer for field services. Field service shall be in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.

2. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for luminaires, including dimensions, type of wiring, weight, size, installation methods, provisions for relamping or replacing luminaires from the ground, test information criteria and rated life in hours with corresponding standard.

3. Photometric data developed for each fixture type.

4. Lamp type and technical information.

5. Ballast type and technical information.

6. Driver type for LED luminaires and technical information including input voltage, power factor, Crest Factor and THD.

7. Scaled Shop drawings showing the locations of all fixtures and devices. The Drawings shall include the proposed routing of the branch circuits.

B. Reports

1. Field test reports shall be submitted.

2. Manufacturer's site visit report shall be submitted.

C. Operations and Maintenance Manuals

1. Operations and Maintenance Manuals shall be submitted in accordance with this Section and the Specifications.

D. Bill of Materials.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Luminaires and devices shall be delivered, stored, and handled in accordance with this Section, the Specifications, and the manufacturer's instructions.

B.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used.

1.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lamps shall be as manufactured by:

1. Cree, Durham, NC;
2. Nichia America Corporation, Wixom, WI;
3. GE Lighting, Cleveland, OH;
4. Osram Sylvania, Wilmington, MA;
5. American Electric Lighting, OH;
6. Appleton Electric Company, Rosemont, IL;
7. Holophane, OH;
8. Lithonia Lighting, Conyers, GA;
9. Solar Lighting International, Wixom, WI
10. Or approved equal.

B. Drivers and Ballasts shall be as manufactured by:

1. Osram Sylvania, Wilmington, MA;
2. Universal Lighting Technologies Inc., Nashville, TN;
3. Eldo LED, Conyers, GA;
4. Advance Transformer, Rosemont, IL;
5. Or approved equal.

C. Emergency inverter systems shall be as manufactured by:

1. Vertiv-Emerson Network Power, Houston, Texas;
2. Emergi-Lite;
3. Or approved equal.

D. General use receptacles shall be as manufactured by:
1. Hubbell Incorporated, Shelton, CT;
2. Arrow-Hart Incorporated, Chicago, IL;
3. Or approved equal.

E. Hazardous location receptacles and 480-volt receptacles shall be as manufactured by:
1. Crouse-Hinds Company, Syracuse, NY;
2. Appleton Electric Company, Rosemont, IL;
3. Or approved equal.

F. General use switches shall be as manufactured by:
1. Hubbell Incorporated, Shelton, CT;
2. Arrow-Hart Incorporated, Chicago, IL;
3. Or approved equal.

G. Hazardous location switches shall be as manufactured by:
1. Crouse-Hinds Company, Syracuse, NY;
2. Appleton Electric Company, Rosemont, IL;
3. Or approved equal.

H. Plates shall be as manufactured by:
1. Hubbell Incorporated, Shelton, CT;
2. Arrow-Hart Incorporated, Chicago, IL;
3. Or approved equal.

I. Covers shall be as manufactured by:
1. Crouse-Hinds Company, Syracuse, NY;
2. Appleton Electric Company, Rosemont, IL;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Luminaires

1. A luminaire shall be provided for each luminaire symbol shown on the Contract Drawings. For lighting, a minimum of two (2) independent circuits with separate control switches shall be provided in each area.

2. Luminaires shall be provided with all necessary hangers, supports, conduit adaptors, reducers, hooks, brackets, and other support hardware. All hardware shall have a protective, non-corrosive finish.

3. Recessed luminaires shall be provided with trim moldings and frames suitable for the types of ceilings.

4. Pendent mounted luminaires shall be suspended by means of an enclosed and gasketed cushion type hanger. The hanger shall be suitable to be mounted directly to the luminaire outlet box and shall provide a minimum of 8 degrees swing from the vertical. Stems shall be threaded rigid metal conduit, 1/2-inch minimum size. In corrosive areas stems shall be PVC coated.

5. Where luminaires are subjected to moisture, or assembled of dissimilar metals, gaskets of approved material and thickness shall be provided.

6. Explosion-proof type luminaires shall comply with the requirements of the NYCEC for the hazardous locations indicated on the Contract Drawings.

7. Luminaires shall be completely wired except where they will be directly connected to branch circuit wiring. The conductors shall be not less than No. 12 gauge, stranded, with approved heat resistant covering.

8. Mounting heights of all luminaires shall be as shown on the Contract Drawings. For special types, the height shall be determined at the time of installation.

9. LED lighting fixtures shall be LM79/LM 80 Compliant.

10. LED lamps shall be cool white.

B. Lamps

1. Lamps in association with their ballasts or drivers shall have voltage ratings suitable for the voltages shown on the Contract Drawings.

2. The color temperature of lamps shall be such that the installed luminaire color temperature is as listed in this Section or shown on the Contract Drawings.

3. LED lamps shall be in accordance with the following:

a. Comply with UL 8750

b. CRI of not less than 85

c. Minimum efficacy of 140 lumens/watt

d. Lamp L80 life of not less than 100,000 hours at 25 degrees C

e. Maximum junction temperature of 150 degrees C

f. Binning per ANSI C78.377 at 85 degrees C

g. Very low thermal resistance to permit optimum heat transfer from the junction to the operating ambient.

h. Heat sink cooling without pumps or moving parts.

i. Correlated color temperature – 4000K, 70 CRI minimum, 3000K, 70CRI or optional 5000K, 70 CRI minimum.

4. Lamps in association with their ballasts or drivers shall have voltage ratings suitable for the voltages as shown on the Contract Drawings.

5. The color temperature of lamps shall be such that the installed luminaire color temperature is as listed in this Section.

6. Solar LED lamps shall be in accordance with the following:

a. 80W 12,800 Lumens (Philips 5050) or approved equal.

C. Drivers and Ballasts

1. General:

a. Ballasts and Drivers shall be matched for proper operation of lamps and shall meet the requirements for luminaire light output, reliable starting and operation.

b. Ballasts and Drivers shall have dimming capabilities and the lamps shall be corresponding suitable for dimming. Dimming requirements shall be listed in this Section or as shown on the Contract Drawings.

c. Ballasts shall be UL listed and certified by approved Nationally Recognized Testing Laboratories (NRTL). Testing Laboratories and shall conform to CBM.

d. High output LEDs integrated with two (2) layer circuit board, ensuring cool running operation.

2. LED Drivers

a. LED drivers shall be matched to their lamps such that the luminaire supply voltage and its likely site variations shall produce a level of performance indicated in this Section and as shown on the Contract Drawings.

b. LED Drivers in conjunction with the respective luminaire construction shall achieve the following:

1) Specified lumen output with variation from specified voltage of plus or minus 10%.

2) Rated life of not less than 100,000 hours.

3) THD of less than 10% across the specified voltage range and full power.

4) Power factor of not less than 95% and over the full range if dimming specified.

5) Consistent performance over the range of temperatures expected at the installation location either indoors or outdoors.

6) Cooling shall be achieved with static arrangements. Active cooling, thermal foldback or thermal sensing to achieve temperature control are not permitted.

c. Electrical connections between LED Drivers and all components of the luminaire shall be polarized and color coded to permit trouble free connection and reconnection. A connection diagram shall be imprinted on the Driver or the internal of the luminaire.

3. Surge protection shall have a minimum of ANSI C136.2, 20kV/10kA protection.

4. NEMA 3 Pin Photocontrol receptacle with the Acuity designed ANSI 7 Pin receptacle.

5. Emergency Inverter Systems

a. Emergency inverter systems shall be provided for operation of exit signs and emergency luminaires. Each system shall be provided with normal input and inverter output voltages, capacity and number of output circuits as shown on the Contract Drawings. The output circuits shall be any combination of up to ten security and emergency circuits.

b. Each system shall consist of an input line circuit breaker, sine wave inverter and battery section complete with the manufacturer's standard monitoring and control functions housed in a vented free

standing enclosure. The enclosure shall have identifying nameplates in accordance with the requirements of Section 26 05 53 – Identification for Electrical Systems. Each system shall be UL 924 listed.

c. The inverter shall be electronic solid-state type suitable for operating all type loads. The batteries shall be sealed, maintenance-free lead calcium and shall include a recharge charger and transfer relay.

d. Each system shall operate on AC single phase normal input power supplying both the security circuits and the battery charger. If the normal power is lost, the inverter shall provide, AC single phase emergency power to operate for up to 90 minutes both the security and the emergency circuits.

e. The system output shall automatically switch to battery power within 750 milliseconds upon an outage of the normal input and when restored transfer back after time delay.

6. Lighting Contactor Panels

a. Lighting contactor panels shall be provided for the control of luminaires where specifically indicated on the Contract Drawings. The panel control and devices shall be arranged for proper operation in accordance with the control schematics shown on the Contract Drawings.

b. The panel enclosures shall be steel, single door type. Enclosures shall be NEMA 12 for dry, indoor areas and NEMA 4X for corrosive areas. Each enclosure shall be equipped with a control fuse with mounting block and 300-volt screw type terminal blocks.

c. Contactors shall be mechanically held type suitable for 120-volt operation and switching ballast type lighting. Contactor voltage, ampere, number of poles and quantities within each panel shall be as shown on the Contract Drawings.

d. Where indicated on the Contract Drawings, the lighting contactor panels shall be provided with selector switches and control relays. Selector switches and control relays shall be heavy duty industrial type.

7. Receptacle and Switches

a. General:

1) Receptacles and switches shall be provided in accordance with the Section and as shown on the Contract Drawings. The receptacles and switches shall be complete and shall include all accessories for proper installation.

2) Outlet boxes for receptacles and switches shall be in accordance with Section 26 05 33 – Raceway and Boxes for Electrical Systems.

3) Explosion proof devices in hazardous locations shall comply with the requirements of the NYCEC for Class I, Division 1, Group D locations.

8. Receptacles:

a. Receptacles shall be duplex grounding type, two pole, three wire, 125-volt AC, 15 amperes. As required, other special receptacles with number of poles, voltage and current rating shall be provided. Matching plugs shall be provided for each special receptacle.

b. Receptacles for indoor dry, dusty locations shall be heavy duty, straight blade type, with reinforced polyester base and impact resistant nylon face.

c. Receptacles for wet and corrosive locations shall be marine duty, straight blade type, with heat resistant melamine body. Special receptacles in wet and corrosive locations shall be Type 316 stainless steel.

d. Receptacles for hazardous locations shall be factory sealed and shall be in accordance with the following:

1) Explosion-proof type receptacles shall be of the delayed action type requiring the turning of a plug shell on withdrawal to allow time for extinction of arcs.

2) Surface mounted explosion-proof receptacles shall be provided with cast iron or cast aluminum angle type covers with hinged flaps.

3) Flush mounted explosion-proof receptacles shall be provided with brass, chromium plated, flush plates with double hinged flaps.

4) Plugs shall be provided where required for each type of explosion-proof receptacle. Plugs shall be of explosion-proof construction and shall have steel bodies with corrosion

resistant finish. Plugs shall be fitted with aluminum alloy cable clamps and chloroprene cable bushings.

e. Receptacles for installation in floors shall be in accordance with the following:

1) Floor receptacles shall comprise a watertight unit consisting of a cast iron box with an adjustable top, permitting permanent angular and vertical adjustment, brass cover plate and 3/4-inch brass floor extension. The extension shall be of an approved height and shall be surmounted with a brass head arranged for a duplex receptacle. Exposed metal parts shall be finished to match adjacent metal finish.

2) For low voltage signal and telephone work, floor outlets shall be equal to those specified above for floor installation, except that the interiors shall be designed for cable extension as approved.

f. Fan or clock outlets shall be single receptacles with molded composition or bakelite bodies. Rating shall be 15 amperes, 125 volts. Fan outlets shall be furnished with stud supports. Clock outlets shall be of the recessed type and shall be furnished with yokes for clock support.

g. 480-volt receptacles in non-hazardous areas shall be a mechanically interlocked type with circuit breaker disconnect. The disconnect cannot be closed until the plug is fully inserted and the plug cannot be withdrawn or inserted unless the switch is open. The receptacle enclosure shall be copper - free aluminum with stainless steel parts.

9. Switches:

a. Switches shall be industrial-heavy duty, AC toggle quiet type. Switches shall be rated 120/277-volt, 20 amperes. Poles and switching shall be as shown on the Contract Drawings.

b. Switches for hazardous locations shall be factory sealed tumbler type. The switch body and cover shall be cast gray iron alloy or cast malleable iron with zinc electroplate finish.

10. Plates and Covers:

a. Stainless steel plates shall be furnished for devices in indoor dry, dusty locations. They shall have beveled edges and shall be made of Type 302/304, stainless steel.

b. Plates shall have satin finish. Attachment screws shall have matching head finish.

c. For wet and corrosive locations neoprene gasketed covers shall be used. Covers shall be galvanized ferrous or cast ferrous metal. Covers shall be PVC-coated in corrosive locations. Covers shall be equipped with gasketed spring doors for receptacles and an external operating mechanism for switches.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Luminaires

1. Luminaires shall be installed at locations shown on the Contract Drawings. Luminaire locations shall be adjusted where necessary to clear conflicts and obstructions.

2. All luminaires shall be installed complete with all hardware and supporting devices necessary to make a safe complete and fully operative installation.

3. The Contractor shall obtain from the manufacturer for each luminaire, diagrams, illustrations, and other installation instructions. The Contractor shall install in strict conformance with such instructions and the requirements of NEC.

4. Recessed fixtures shall be installed in suspended ceiling openings in conformance with manufacturer's recommendations and to suit the architectural details of the area involved. Independent supports from structural members of the building shall be provided.

5. Every LED luminaire shall have at least two (2) supports, and continuous lines of LED luminaire shall be supported at 4-foot intervals.

6. Pendent mounted fixtures shall be installed with pendants 1/2 inch for stems up to five (5) feet and 3/4 inch for longer lengths.

7. All pendant stem hangers shall be furnished with suitable aligner canopies or outlet box covers so that the luminaires hang vertical to the finished floor irrespective of the angle of the surface from which they are suspended. When luminaires or hanger canopies are mounted flush to the ceiling or wall, and where raceways and outlet boxes serving the luminaires are surface mounted to the ceiling or wall, finishing rings shall be provided to conceal the outlet box. All visible hanging devices and appurtenances shall have the same finish as the luminaire.
8. Reflectors, lenses, diffusers, louvers, and decorative elements of luminaires shall not be installed until completion of plastering, ceiling tile work, painting, and general clean-up in the area.
9. Solar Light Fixtures shall be pole mounted at the height of 20 feet as per manufacture requirements.

B. Emergency Inverter System:

1. Equipment shall be installed in accordance with manufacturer's instructions and recommendations.
2. Equipment shall be installed on concrete pads at locations indicated on the Contract Drawings so that sufficient access and working space is provided for ready and safe operation and maintenance.
3. Install system nameplates for identification of equipment.

C. Lighting Contactor Panels:

1. Panels shall be mounted rigidly and securely to the building structure or to supporting devices which are rigidly and securely supported to the building structure.
2. Panels shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units and with machine screws or welded studs on metal.
3. All panels shall be mounted parallel or perpendicular to walls, such that panels are installed in a neat and professional manner.

D. Receptacles and Switches:

1. Receptacles and switches shall be installed within outlet boxes at locations indicated on the Contract Drawings and in accordance with code requirements.
2. Receptacles shall be mounted two (2) feet above the finished floor, except in hazardous locations where receptacles shall be mounted 4 feet-6 inches above the finished floor.

3. Switches shall be mounted 4 feet 6 inches above the finished floor.

4. Where devices are grouped, they shall be mounted under a common plate. Where directed or where space conditions limit gang mounting, tandem or tandem gang arrangement shall be provided.

5. Where four (4) or more switches controlling fixtures that are not visible from the switch location are grouped, the switch plate shall be engraved and filled with colored material or otherwise suitably marked to designate the control of each switch.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, the completed lighting system and receptacle devices shall be field tested for operation and conformance. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:

   a. Wiring continuity test shall be performed.

   b. Branch circuit load balance test shall be performed.

   c. Fixture and control operation test shall be performed.

   d. Emergency inverter system operation and functionality test shall be performed.

   e. Receptacle polarity and grounding.

B. Reports

1. The Contractor shall provide a field test report. The report shall identify the test performed and the results obtained.

C. Manufacturer's Field Services

1. A qualified manufacturer's service representative shall assist in the installation of the emergency inverter system, check the installation before it is placed into operation, assist in the performance of field tests, observe the initial operation and train the plant operations and maintenance staff in the care, operation and maintenance of the system.

2. The Contractor shall provide equipment start-up services and training in accordance with this Section and the Specifications.

3. The Contractor shall provide a field report from the manufacturer's representative for each visit to the site. The report shall include complete information on time, schedule, tasks performed, persons contacted,

problems corrected, tests results, training instruction and all other pertinent information.

4. The service representative shall sign in with the Engineer on each day they are at the site.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning of Luminaries

1. Luminaires shall be cleaned inside and out to remove construction dust prior to the start of Field Tests and again prior to substantial completion at the direction of the Engineer.

2. Fixtures shall be relamped prior to substantial completion.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing outdoor lighting. Outdoor lighting shall be provided in accordance with the requirements under this Section, the Specifications, and the Contract Drawings.

B. The outdoor lighting system shall be complete and include all luminaires, poles, pole bases, reinforced concrete foundations and accessories as required for the installation of the outdoor lighting.

C. The Contractor shall perform all excavations, complete all forms, and do backfilling and tamping as required, unless specifically shown otherwise on the Contract Drawings.

D. The following index of this Section is included for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 01 65 00	-	Product Delivery Requirements
B.	Section 03 30 00	-	Cast-in-Place Concrete
C.	Section 03 21 00	-	Reinforcing Steel
D.	Section 05 12 00	-	Structural Steel Framing
E.	Section 26 05 20	-	Low Voltage Wires, Cable and Accessories
F.	Section 26 05 27	-	Grounding
G.	Section 26 05 29	-	Hangers and Supports for Electrical Systems
H.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems
I.	Section 26 05 53	-	Identification for Electrical Systems
J.	Section 26 51 11	-	Lighting Fixtures, Devices and Schedules
K.	Section 31 23 16	-	Excavation
L.	Section 31 23 23	-	Fill

1.04 REFERENCES

A. Outdoor lighting shall comply with the latest applicable provisions and recommendations of the following even if not specifically listed in this Section:

1.	DLC PR	-	Design Lights Consortium Premium Technical Requirements
2.	EISA 2007	-	Energy Independence and Security Act of 2007
3.	IES LM-79	-	Approved Method: Electrical and Photometric Measurements of Sold State Lighting Products
4.	IES LM-80	-	Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
5.	IES TM-21	-	Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources
6.	NEMA SSL-1	-	Electronic Drivers for LED Devices, Arrays, or Systems.
7.	NEC	-	National Electrical Code.

8.	UL 1029	-	High Intensity Discharge Lamp Ballasts.
9.	UL 1572	-	High Intensity Discharge Lighting Fixtures.
10.	UL 1598	-	Luminaires
11.	UL 8750	-	Light Emitting Diode (LED) Equipment for Use in Lighting Products.
12.	UL 1993	-	LED Light Bulbs with Drive-in Circuits.
13.	UL 844	-	Electric Lighting Fixtures for Use in Hazardous Locations

14. American National Standards Institute, ANSI –

    a. ANSI C78.377 - Chromacity of Solid-State Lighting Products

15.	NFPA 70	-	National Electrical Code
16.	ASCE 7-16	-	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
17.	AASHTO	-	Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, American Association of State Highway and Transportation Officials, Washington D.C.

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. General

1. Luminaires shall be UL listed and approved for use and comply with NEC.

2. The types of luminaires are noted within the fixture schedule which is shown in this Section. The descriptions and catalog numbers serve to establish the quality, appearance, and performance of the specified luminaires.

3. Luminaires shall comply with DLC PR.

4. All outdoor lighting luminaires, poles and associated equipment shall be the products of lighting equipment manufacturers and manufacturers who have previously demonstrated, by performance and reputation, the ability to manufacture products of the quality specified and shall have a minimum of five (5) years' experience manufacturing the specified products. Such manufacturers must maintain an organization and manufacturing facility capable of actually manufacturing the specified luminaires, poles and associated equipment. For the purpose of inspection, Contractor shall assure the Engineer, free and easy access to the manufacturing facilities and

inventories of any manufacturer whose equipment the Contractor proposes to supply.

5. Outdoor lighting system shall use low carbon alloy steel with minimum yield strength of 50,000 psi or stainless-steel bolts, nuts, washers, and screws.

6. Contractor shall ensure that all metals used for poles, bases, support hardware, bolts, nuts washers and screws are of similar material composition and where different, the Contractor shall provide an isolation kit in accordance with Section 05 12 00 - Structural Steel and steps are taken to mitigate the effects of corrosion.

7. The Contractor shall be responsible for reviewing all drawings and coordinating with all trades the installation of lighting fixtures and devices and lighting poles.

8. All industrial fixtures shall be of the highest quality material and construction for their respective types.

9. Lamps for all lighting fixtures shall be in accordance with the Federal Energy Legislation for reduced energy consumption.

10. Fixtures shall be suitable for connection to concealed or exposed conduit runs as required in each particular location and shall be of sizes suitable for lamp sizes indicated on the Contract Drawings.

11. Fittings and other materials for special fixtures not definitely shown or specified shall be of approved material, make and quality and shall have a finish that will harmonize with other parts of the fixtures. Where suitable standard materials are not available, such parts of the fixtures shall be specially manufactured.

B. Field Testing

1. The outdoor lighting system shall be field tested. The field testing shall be performed in accordance with the requirements specified under this Section.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittal shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.

2. Manufacturer’s catalog cuts and drawings showing all technical information, and construction details for luminaires, including dimensions, type of wiring, weight, size, installation methods and provisions for relamping luminaires from the ground.

3. Photometric data developed for each fixture including IES BUG ratings, isolux diagrams and IES lighting classification.
4. Lamp type and technical information.
5. Ballast type and technical information including power factor, input watts and ballast factor.
6. Driver type for LED and technical information including input voltage, power factor, Crest Factor and THD.
7. Pole and base construction details. For poles submit wind loading, complete dimensions, and finish, include anchor bolt sizing and circle diameter.
8. Scaled Shop drawings showing the locations of all luminaires and shall include the proposed routing of supply conduits of the branch circuits.
9. Bill of Materials.
10. Contractor shall submit lighting fixtures weight and pole mounting wind blow withstanding calculations for review and approval. The calculations shall be prepared and stamped by a NYS Licensed Professional Engineer.
11. Operations and Maintenance (O&M) Manuals shall be submitted in accordance with this section.

B. Reports:

1. Field test reports shall be submitted.
2. Manufacturer's site visit report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Outdoor lighting equipment shall be delivered, stored, and handled in accordance with this Section, the Specification 01 65 00 – Product Delivery Requirements, and the manufacturer's instructions.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Spare Parts

1. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the outdoor lighting in accordance with this section and the Specifications.
2. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.
3. The following spare parts shall be furnished, with all fractions rounded up to the next number:

a. Ten (10) percent lamps, lamp module or array shall be provided of each wattage of each type of lamp, lamp module or array but not less than the requirement for two luminaires.

b. Where the lamp, lamp module or array is an integral part of the luminaire and the lamp, lamp module or array is not normally replaceable provide spare luminaires instead.

c. Five (5) percent ballasts or drivers shall be provided of each type of type ballast or driver, but not less than two.

d. Ten (10) percent fuses shall be provided of each size and type, but not less than two.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Luminaires

1. Luminaires shall be provided for each lighting fixture symbol as shown on the Contract Drawings. Luminaires shall be provided in accordance with the lighting fixture schedule shown on the Contract Drawings. Manufactures of luminaires shall be in accordance with Section 26 51 11 – Lighting Fixtures, Devices and Schedules.

B. Breakaway In-Line Streetlight connectors shall be as manufactured by:

1. Buchanan, Hackettstown, NJ;

2. Ideal Industries, Sycamore, IL;

3. Ilsco, Cincinnati, OH;

4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Luminaires

1. Luminaires shall be provided for each lighting fixture symbol shown on the Contract Drawings and in accordance with the lighting fixture schedule shown in the Contract Drawings and Section 26 51 11- Lighting Fixtures, Devices, and Schedules.

2. Heights of all outdoor luminaires shall be as shown on the Contract Drawings.

3. All lighting fixtures shall be LED type as shown on the Contract Drawings.

4. Heights of all outdoor fixtures shall be as shown on the Contract Drawings.

5. Lighting Fixtures shall have Universal Mounting Bracket to be installed on the outdoor lighting poles.

B. Poles and Bases

1. Poles and bases shall be provided in accordance with the details shown on the Contract Drawings.

2. Poles shall have a wind load rating of at least 98 miles per hour (mph) with a gust factor of 1.3 and shall be made of seamless shaft steel.

3. Bases shall be provided with plug receptacles, fuses, cut-outs, switches or other devices for protection and ease of maintenance. Devices shall be in accordance with the following:

a. Receptacles shall be housed in cast iron hot-dipped galvanized boxes and shall be watertight, heavy-duty type with screwed caps.

b. Switches shall be enclosed in hot-dipped galvanized cast iron boxes. Switches shall be provided with fuses.

c. Fused applications shall be provided with breakaway watertight, in-line fuse kits.

C. Reinforced Concrete

1. Concrete for pole foundations shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete, and the concrete steel reinforcement shall be in accordance with Section 03 21 00 – Reinforcing Steel.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Luminaires shall be installed at locations indicated on the Contract Drawings. Fixture locations shall be adjusted where necessary to clear conflicts and obstructions.

B. Excavation for luminaire poles shall be in accordance with the requirements of Section 21 23 15 - Excavation.

C. Backfilling for fixture poles shall be in accordance with the requirements of Section 31 23 23 - Fill.

D. Luminaire poles shall be installed on reinforced concrete foundations as shown on the Contract Drawings. Poles shall be installed in accordance with standard procedures and as recommended by the manufacturer.

E. Poles shall be wired with strain relief provided. A green grounding conductor shall be installed with each circuit, grounding by conduit method shall not be permitted.

F. Lighting fixtures shall be mounted in such a way to reduce spill light.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Tests

1. After installation, the completed outdoor lighting system shall be field tested for operation and conformance.

2. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide testing consisting of the following:

a. Wiring continuity test shall be performed.

b. Branch circuit load balance test shall be performed.

c. Fixture and photocell operation test shall be performed.

B. Report

1. The Contractor shall provide a field test report.

2. The report shall identify the tests performed and the results obtained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning of Outdoor Lighting

1. Luminaires shall be cleaned inside and out to remove construction dust prior to substantial completion.

2. Luminaires shall be relamped prior to substantial completion.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the requirements for the Contractor to coordinate the extension or relocation of fiber optic service drop with the Ethernet Wide Area Network (WAN) service providers.

B. This Section includes the requirements for the Contractor to obtain the services of Communications Network Integrator (CNI), who shall furnish all materials, equipment, labor and services required to achieve a fully integrated and operational communications system as specified herein and shown in the Contract Drawings.

C. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust, and place into satisfactory operation the communications network.

D. The following index of this Section is presented for convenience:

E.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements

B. Section 26 05 27 - Grounding

C. Section 26 05 53 - Identification for Electrical Systems

D. Section 27 05 26 - Grounding and Bonding for Communication Systems

1.04 REFERENCES

A. Definitions:

1.	NYC DEP BIT	-	New York City Department of Environmental Protection Bureau of Information and Technology
2.	NYC DEP BPS/ SEU	-	New York City Department of Environmental Protection Bureau of Police and Security/ Security Engineering Unit

B. Reference Standards:

1.	NFPA 70	-	National Electrical Code
2.	ANSI/TIA-568.0	-	Generic Telecommunications Cabling for Customer Premises
3.	ANSI/TIA-568.1	-	Commercial Building Telecommunications Infrastructure Standard
4.	ANSI/TIA-568.2	-	Balanced Twisted-Pair Telecommunications Cabling and Components Standards
5.	ANSI/TIA-568.3	-	Optical Fiber Cabling Components Standard
6.	ANSI/TIA-569	-	Telecommunications Pathways and Spaces
7.	BICSI TDMM	-	Building Industries Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM)
8.	ANSI/NECA/ BICSI N1	-	American National Standards Institute/National Electrical Contractors Association/Building Industry Consulting Services International, Installation Practices for Telecommunications a and ICT Cabling and Related Cabling Infrastructure
9.	ANSI/TIA/EIA 598	-	Optical Fiber Cable Color Coding

10.	ANSI/TIA/EIA - 604.2-A FOCIS 2	Fiber Optic Connector Intermateablility Standard (FOCIS)
11.	TIA/EIA 606 -	Administration Standard for Telecommunications Infrastructures

1.05 DESCRIPTION

A. System Description:

1. The Kensico campus is provided WAN access through Verizon's Metro Ethernet and Cablevision's (Altice) Carrier Ethernet services. The Network Interface Devices (NIDs) for both services are in the EOH Headquarters building. Kensico's WAN router and main Ethernet network switch are also in the EOH Headquarters building. All buildings on the Kensico campus are connected to the main Ethernet network switch via fiber optic cables forming an extended star network topology.

2. The existing fiber service drop cables for both Ethernet WAN services (Verizon and Altice) enter the EOH Headquarters aerially on the second floor. New fiber service drop cables for both Ethernet WAN services shall enter the EOH Headquarters underground via ductbanks and reconnected to the respective NIDs.

3. The Electrical building's Local Area Network (LAN) shall be configured and connected to the EOH Headquarters' main Ethernet network switch.

4. The Lower Effluent Chamber's (LEC) new Ethernet network switch shall be configured and connected to the EOH Headquarters' main Ethernet network switch.

B. General Requirements and Restrictions:

1. The following general criteria shall apply to the Work except where otherwise noted in the Contract Documents:

a. This section covers the requirements for the new routing of the fiber optic service cables, configuring the new LAN at the Electrical building, modifying and reconfiguring the existing LAN at the LEC, and tying both LANs to the main Ethernet switch at the EOH Headquarters building. The Contractor is responsible to configure all network equipment in coordination with NYC-DEP BIT and the Engineer

b. The Contractor shall coordinate with the existing Metro Ethernet/Carrier Ethernet service providers, Verizon, and Cablevision, to relocate the fiber optic service drop points to the locations shown on the Contract Drawings. In addition, the service drop cables shall be extended to the EOH Headquarter building as shown on the Contract Drawings.

c. The Contractor shall be responsible for meeting all necessary requirements from the service providers for the relocation of the fiber optic service drops and extension of the fiber optic service drop cables. This includes but not limited to new patch panels and NIDs if required.

d. Once the new fiber optic service drop cables have been connected to the NIDs, the Contractor shall check and test that the Kensico campus network has Ethernet WAN connectivity from Verizon and Altice.

e. The configuration of the new LANs and modifications to the existing LANs at the Kensico campus are to be completed by a single network integrator for the duration of the Contract – referred to as the Contractor's CNI. The Contractor's CNI is to coordinate and work in conjunction with NYC-DEP BIT, BPS/SEU and the Engineer. System specific hardware, such as IP cameras, gateway devices, switches, and other equipment can be configured by Subcontractors responsible for such systems as directed by the Contractor's CNI, NYC-DEP BIT, and the Engineer. Configuration of all hardware by anyone other than the Contractor's CNI is subject to preapproval by the Engineer.

f. The Contractor shall retain the services of a CNI to assume the responsibilities specified. However, execution of these specified duties by the CNI shall not relieve the Contractor of the ultimate responsibility for the Electrical and LEC buildings and associated facilities' network systems.

    1) Design, implement, and configure the networks in accordance with Contract Documents and all applicable or referenced standards and codes.

    2) Preparation, assembly, and updating of all networking submittals in accordance with the Contract Documents.

    3) Proper interfacing of the network hardware, including required interfacing with equipment furnished by other suppliers.

    4) Coordination of all network configuration details with NYC-DEP BIT, BPS/SEU and the Engineer.

    5) Programming of all configuration details, including but not limited to, IP addresses.

    6) Testing and start-up of the networks.

    7) Training of the City personnel on Operation and Maintenance (O&M) of the new LAN at the Electrical building and the modified and reconfigured LAN at the LEC.

8) Handling of all warranty obligations for the network components.

9) Development of O&M documentation for the network systems.

10) Modification of existing O&M manuals as required.

g. Contractor's CNI to be available throughout the duration of the Contract to provide consultation, installation, configuration, and general support for the networks as they are put into service during the Contract at no additional cost to the City.

h. Contractor to provide and configure new hardware where required to provide support for the fiber optic system. Provide enclosures, equipment, and other ancillary equipment as necessary.

i. Various systems at the Kensico buildings will be brought online at various times. The Contractor must be prepared to configure and support the Electrical and LEC building networks as systems are completed and brought online.

j. The Contractor is responsible for proposing configurations and then coordinating with NYC-DEP BIT and BPS/SEU as noted in the Specifications. Contractor is then responsible for configuring all equipment in coordination with and at the direction of NYC-DEP BIT and BPS/SEU. NYC-DEP BIT or BPS/SEU may elect to take delivery of a piece of equipment and configure it themselves. This does not absolve the Contractor from providing all equipment and labor necessary to fully install and connect the equipment as required by NYC-DEP BIT and BPS/SEU. Where NYC-DEP BIT or BPS/SEU chooses to configure a piece of equipment themselves, the Contractor is not liable for the configuration of said equipment. The Contractor shall remain liable for warranty services for the hardware.

k. References made to the "NYC-DEP network" are in relation to the domain and IP addressing pertaining to the existing NYC-DEP LANs and WANs. Kensico buildings' LANs that are connected to this network and properly IP addressed are typically available from remote location offices that are a part of the wider NYC-DEP network. The Contractor is not responsible for configuration or programming changes to existing NYC-DEP network offsite equipment except as expressly noted in the Contract Documents.

2. The following general restrictions shall be applied to the Work and to all equipment except where otherwise noted in the Contract Documents:

a. All connections between the Internet and the Kensico campus network are to take place through NYC-DEP BIT provided services.

At no time is the Contractor permitted to make such a connection without the express written consent of NYC-DEP BIT and the Engineer. If such a connection is granted by NYC-DEP BIT and the Engineer, the Contractor shall follow all security measures, restrictions and instructions as directed by NYC-DEP BIT and the Engineer.

b. All Contractor computers, laptops, or other systems that are to be connected to any of the Kensico buildings' LANs shall be subject to all security measures, restrictions, and instructions as directed by NYC-DEP BIT and the Engineer prior to being connected to any of the Kensico LANs or other networked equipment.

c. All Contractor removable media, including, but not limited to, floppy disks, USB flash drives, and portable hard drives, are subject to all security measures, restrictions, and instructions as directed by NYC-DEP BIT and the Engineer.

d. All computer systems and other network hardware supplied by the Contractor under this Contract or otherwise shall be subject to the security measures, restrictions, and instructions as directed by NYC-DEP BIT and the Engineer. The security measures implemented by NYC-DEP BIT are continuously evolving. The Contractor is to abide by the measures that NYC-DEP BIT sets forth throughout the duration of the Contract.

e. At no time is the Contractor to establish a remote connection to any computers or other equipment on the Kensico campus network without express written permission from NYC-DEP BIT and the Engineer. If such a connection is granted by NYC-DEP BIT and the Engineer, the Contractor shall follow all security measures, restrictions, and instructions as directed by NYC-DEP BIT and the Engineer.

C. System Requirements:

1. IP Addresses:

a. All equipment IP addresses are to be static unless otherwise noted herein or directed by DEP BIT, BPS/SEU, or the Engineer.

b. Contractor to propose and program IP ranges for each network as well as individual IP addresses for each piece of equipment at the Electrical and LEC building. The proposed ranges to be commented on and approved by NYC-DEP BIT and the Engineer.

2. Uninterruptable Power Supply (UPS)

a. Provide rack mounted UPS to power all network rack equipment for two (2) hours minimum.

b. Provide all cabling, accessories, and connections necessary to provide fully functional system.

3. Virtual Local Area Network (VLAN):

a. Configure the network switches to provide any required VLANs. Coordinate with NYC-DEP BIT and the Engineer for the type VLAN required and for the configuration and assignment of all network devices that are to be part of a specific VLAN.

4. Network Architecture:

a. Each building's (Electrical, LEC, and EOH Headquarters) network is a separate and individual network as shown on the Contract Drawings.

b. Provide new managed switches and all other necessary hardware to create new networks as shown on the Network Architecture/Block Drawings. All managed switches are to be configured to limit network traffic such that interconnection between the networks at any location will not cause network outages or problems.

c. Contractor to coordinate the IP addressing for each network with NYCDEP BIT and the Engineer.

d. Contractor is to configure all equipment in coordination with NYC-DEP BIT and the Engineer.

5. LAN Configuration:

a. Provide, program, and configure managed network switches and all other hardware required to create a LAN as indicated on the Contract Drawings.

b. The LAN is to provide IP addressing compatible with the DEP network. Program and configure IP addresses in coordination with and at the direction of NYC-DEP BIT and the Engineer.

c. Configure the managed switch to provide DHCP service to assign IP addresses and other network information to Security and CCTV equipment or other equipment that may be connected to this network. Configuration to be done in coordination with and at the direction of NYC-DEP BIT and the Engineer.

d. Configure the managed switch to route network traffic to the other networks interconnected at the EOH Headquarters building in coordination and at the direction of NYC-DEP BIT and the Engineer.

e. Test the configuration by connecting a laptop and network pinging at least three pieces of equipment on each of the other networks.

f. Workstations, laptops, or other equipment connected to the security VLAN shall be able to connect to and view network video feeds from the Security CCTV NVR.

1.06 QUALITY ASSURANCE

A. CNI

1. The CNI shall assume responsibility for providing a modified and completely integrated campus network system.

2. The system is to contain products of a single manufacturer, when possible, and to consist of equipment models, which are currently in production.

B. CNI's Qualifications:

1. Shall be a financially sound firm having at least ten (10) years continuous experience in designing, implementing, supplying and supporting computer network systems, which are comparable to the computer network system at Kensico in terms of hardware, software, cost and complexity.

2. Shall have in existence at the time of bid advertisement, an experienced Engineering and Technical staff capable of designing, implementing, supplying and supporting the network system and handling the network system submittal and training requirements.

3. Shall provide system hardware components and software packages of fully developed, field proven standardized designs and therefore shall furnish a network system which is not a highly unique, custom one-of-a-kind system.

4. Shall provide standard course offerings in general computer networking, and in network operation, programming and maintenance.

5. Shall have a demonstrated record of prompt response to field failures.

6. Shall have a documented program of failure analysis.

7. Shall have a record of prompt shipments in accordance with Contract obligations required for previous projects.

8. The Contractor's CNI must have a minimum of five (5) years industrial routing and switching experience.

9. The Contractor's CNI must have successfully completed at least three (3) or more projects, similar to the work described in this Section and related Sections, in the last three (3) years.

10. The Contractor's CNI must have successfully completed five (5) or more projects, similar to the work described in this Section and related Sections.

11. The Contractor's CNI must be Cisco CCIE Routing and Switching certified.

12. The City reserves the right to reject any Subcontractor deemed to be insufficiently qualified.

C. Technical Proposal Requirements

1. The Contractor shall submit a copy of a Technical Proposal from the CNI selected..

2. The Technical Proposal shall be complete and at a minimum contain all information as specified below:

a. Financial Statement

1) Shall include the value of network systems delivered during the last five (5) fiscal years.

b. Experience

1) Shall provide evidence of compliance with the specific experience requirements under the CNI Qualification listed in this Section in the form of an experience certification signed by an officer of the company.

2) Shall furnish list of last ten (10) projects completed.

3) Shall describe at least three (3) completed municipal projects involving network systems identical to or similar to (indicate which) that specified in this Section.

4) Shall indicate project name, value, completion date, names and phone numbers of representatives familiar with each project.

5) Letters of recommendation submitted does not relieve the Contractor from complying the requirements in this Section

c. Personnel

1) Shall provide a listing of those personnel committed to be assigned to the Contract.

2) List shall include Project Manager, Project Engineer, Field Representative, Local Service Representative, and Sales Representative.

3) Shall identify addresses of personnel not based at CNI's main office.

4) Shall provide documentation including resumes of personnel demonstrating experience in computer networking.

d. Exceptions

1) Shall list all exceptions and deviations from the requirements of the Contract.

2) Shall reference the Drawing Number, Section number, article, and paragraph of proposed variance and provide an explanation of why the proposed exception or deviation meets (or exceeds) the functional or equipment requirements specified.

e. Shipment Records

1) Shall provide evidence of timely delivery of equipment on past projects.

f. Network System Hardware and Software:

1) Shall provide a general system configuration drawing and include designations for model numbers and types of the proposed network equipment and all other proposed system components.

2) Shall provide descriptive literature and manufacturer's catalog information covering all aspects of the hardware design and software functions and capabilities of the specific network system proposed.

3) Shall provide descriptive literature and catalog information covering the features and capabilities of all proposed hardware components.

4) Shall describe standard software packages proposed, including any customized software required to meet the functional intent of the system Specifications.

5) Descriptions shall address the following:

a) Overview of system software including the functions, organization and interrelationship of the major software applications provided.

b) Real-time data logging and reporting software features and capabilities including examples of logs and reports, procedures for automatic reporting and logging file setups, limitations on sampling and computing frequency for data acquisition and logging, and utilities for log file and report modifications and file maintenance.

c) Use of system level diagnostics for monitoring the performance of and detecting and reporting faults associated with the network system.

g. Training

1) The Contractor shall provide information and literature as to the organization proposed for the training specified.

2) Indicate the qualifications of the factory training staff.

D. Coordination and Progress Meetings:

1. The Contractor shall be responsible for the scheduling and coordinating the system installation with regard to all other work on the site and in

accordance with the provisions of the General Conditions. Said coordination shall be documented on the project schedule.

2. Routine progress and coordination meetings will be scheduled by Engineer. The Contractor and a representative of the CNI shall be required to attend a minimum of one meeting per month for the length of Contract.

3. The purpose of the meetings shall be to review the progress of the work involving the new and modified networks and provide coordination for installation of the equipment to ensure construction schedules are met.

4. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit the Contractor and the CNI to agreed procedures and schedules.

E. CNI Project Personnel

1. The Contractor shall require the CNI to provide the following project personnel:

a. Project Manager

1) The CNI shall appoint a Project Manager who shall coordinate and schedule all work and assure that the Contract schedule is met.

2) The Project Manager shall have a minimum of ten (10) years' experience in coordination, scheduling and delivery of computer networking contracts under similar facilities as this Contract and have a thorough working knowledge of contract administration as both a prime and sub-prime Vendor/Contractor.

3) The Project Manager shall act as the liaison with the Contractor for the installation of the network system and shall assist in all matters required for proper coordination and interfacing of the networking equipment.

b. Field Engineer

1) The CNI shall appoint a Field Engineer with responsibilities as follows:

a) Provide advice and technical consultation relative to installation techniques and procedures for equipment furnished.

b) Installed system checkout, adjustment and start-up.

c) Involvement in the on-site network system training.

d) Resolving of network system problems encountered during initial start-up and testing of network equipment.

2) The Field Engineer shall have a minimum of ten (10) years' experience in network systems engineering and start-up and shall have a thorough working knowledge of both the hardware and software supplied.

c. Training Personnel:

1) Training personnel shall have the proper certifications in computer networking.

1.07 SUBMITTALS

A. Shop Drawings General

1. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer.

2. Shop Drawing preparation shall not commence until after the pre-submittal conference specified below.

3. Network equipment shall not be provided or configured until related equipment submittals have been approved by the Engineer.

4. Shop Drawings shall be submitted in complete packages grouped to permit review of related items as generally outlined in this Section under Submittal Requirements.

5. Review of Shop Drawings will be for conformance with Contract Documents and with regard to functions specified to be provided.

B. Pre-Submittal Conference

1. The Contractor shall arrange and conduct a pre-submittal conference within forty-five (45) days of notification of preliminary acceptance of the proposed CNI by the City and the Engineer.

2. The pre-submittal conference shall be attended by representatives of Contractor, the CNI, and the Engineer. The Contractor shall allocate one (1) full working day for the conference and that time shall be included in the price of this Contract. The meeting shall be held at Kensico or at a location approved by the Engineer.

3. The purpose of the pre-submittal conference shall be to review informally and approve the manner in which the CNI intends to respond to the Contract requirements before any submittals are prepared.

4. Contractor shall prepare the items listed below for presentation at the pre-submittal conference. The information shall be submitted to Engineer four (4) working weeks prior to the date of the conference.

a. List of equipment and materials required for the new and modified networks and the brand and model which Contractor proposes to use for each item or component of the proposed system.

b. List of proposed exceptions to the plans and specifications along with a brief explanation of each.

1) Approval of exceptions and substitution shall be subject to a formal submittal according to the Contract procedure.

c. Sample of each type of submittal specified herein. These may be submittals prepared for other projects.

d. A flow chart showing the steps to be taken in preparing and coordinating each network submittal to the Engineer, and a list of proposed submittals.

e. Schedule for all network system related activities from the pre-submittal conference through start-up and training.

1) Particular emphasis shall be given to dates relative to submittal, design, fabrication, programming, factory testing, delivery, installation and field testing.

2) The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.

3) Schedule shall conform to requirements for Contract schedules.

f. General outline of the type of tests to be performed to verify that the network system and all its components are functioning properly.

C. Submittal Requirements:

1. Submit product information for all hardware, include the following:

a. Manufacturer's product name and model number.

b. Instrument tag number from Contract Documents.

c. Manufacturers' standard catalog product data.

d. Description of construction features.

e. Performance and operation data.

f. Installation and mounting details, instructions and recommendations.

g. Service requirements.

h. Dimensions.

D. Network Information:

1. System Description

a. Detailed block diagram showing system hardware configuration and identifying model numbers of system components.

b. Software language and organization:

1) Format, protocol and procedures for network communications.

2. Network Design:

a. Drawings showing the network layout and interconnections.

b. Network routing plan.

c. Equipment Locations.

3. Equipment Hardware

a. Layout drawings showing front, rear, end and plan views to scale of all network equipment, power supplies and peripheral devices.

b. Construction details, features and procedures.

c. Drawings showing equipment layout in network racks.

d. Installation requirements, instructions and/or recommendations

4. Software Description

a. Standard technical documentation covering all aspects of the software functions and capabilities, including instruction set description and programming procedures related to control, monitoring, display, logging, reporting and alarming functions

b. Standard technical and instructional documentation covering software for system support, system documentation, display, communications, data logging and storage and diagnostic functions.

c. Detailed functional descriptions of application programs explaining control, display, logging and alarming features to be provided and functions to be performed.

5. Network Racks Information:

a. Layout Drawings shall include the following:

1) Front, rear, side, end and plan views to scale.

2) Dimensional information

3) Tag number and functional name of components mounted in the network rack.

4) Product information on all network rack components.

5) Nameplate location and legend including text, letter-size and colors to be used.

6) Location of anchoring connections and holes.

7) Location of external wiring and/or piping connections.

8) Mounting and installation details.

9) Calculations for heating and cooling, if enclosed or enclosed and NEMA 12 rated.

E. Network O&M Manuals

1. The Contractor shall furnish O&M manuals for the networks in accordance with the Section 01 78 25 – Operation and Maintenance Manuals, this Section and the following minimum requirements:

a. Name, address and telephone number of the CNI Supplier's local service representative.

b. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.

c. Copy of all approved submittal information and system shop drawings as specified herein with corrections made to reflect actual system as tested and delivered to the site for installation.

d. Half-size black line reproductions shall be provided for all shop drawings larger than 11 by 17 inches.

e. All drawings shall be 11 by 17 inches minimum size.

1) Drawings 8-1/2 by 11 inches are not acceptable.

f. Manufacturer's Original Copies of Hardware, Software and Installation, Assembly and Operations Manuals for the network system, and all other network system components.

g. Manuals shall include the following information:

1) General descriptive information covering the basic features of the equipment

2) Physical description covering layout and installation requirements and all environmental constraints.

3) Functional and operational descriptions covering the procedures for programming, operation, start-up, shutdown, of the network system equipment.

4) Principles of operation explaining the logic of operation; provide information covering operation to a component level.

5) Maintenance procedures covering checkout, troubleshooting, and servicing.

a) Checkout procedures shall provide the means to verify the satisfactory operation of equipment,

b) Troubleshooting procedures shall serve as a guide in determining faulty components and

c) Servicing procedure shall cover requirements and recommended time schedule for cleaning, and other housekeeping and preventive maintenance procedures.

6) Safety considerations relating to operation and maintenance procedures.

F. Record Drawings and Documentation

1. The Contractor shall require the CNI to revise all system shop drawings, submittals and software documentation to reflect as-built conditions in accordance with the requirements of the Contract Documents and the supplemental requirements.

2. All revised shop drawings and documentation shall be submitted to the Engineer per Section 01 78 40 – Final Record Documents to replace outdated drawings and documentation contained in the system O&M Manuals.

3. Half-size black line sets shall be provided for all drawings larger than 11 x 17. Specific instructions for outdated drawing removal and replacement shall be provided with the record drawing submittal.

4. Half-size black line prints of wiring diagrams applicable to each control panel shall be provided inside a clear plastic envelope and stored in a suitable print pocket or container inside each control panel.

G. Reports:

1. The following test reports shall be submitted shall be submitted to the Engineer:

a. Test plans and procedures.

b. Test Results.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Communication network equipment shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools, and supplies with the Communications equipment, neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. CNI shall be:

1. Black Box, Lawrence, PA
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Not Used.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

3.03 FIELD TESTING / QUALITY CONTROL

A. Final field tests shall be performed for all communication equipment provided.

B. The system testing is to demonstrate the functionality and design of the network performs as specified.

C. Testing to include internetwork connectivity and routing via pinging or other approved means. The testing shall include accessing at least three (3) devices from each network.

D. Testing to include verifying DHCP services are operational as specified.

E. Testing to include verifying NYC-DEP network access by following test procedures developed by NYC-DEP BIT.

3.04 STARTUP / DEMONSTRATION

A. Provide support services to work with DEP-NYC BIT to bring each system on line as it is completed and ready.

B. Provide a visit of two (2) days duration for each of the LANs to be brought on line.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for providing grounding:

1. Grounding and bonding shall be provided in accordance with the requirements specified under this Section, the Specifications, and the Contract Drawings.

2. The grounding and bonding work shall be a complete and fully functioning grounding and bonding system for the communication systems.

3. All grounding and bonding shall meet the NEC as well as local codes, which specify additional grounding and/or bonding requirements.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements

B. Section 26 05 27 - Grounding

C. Section 26 05 33 - Raceways and Boxes for Electrical Systems

D. Section 26 05 53 - Identification for Electrical Systems

E. Section 27 11 16 - Communications Cabinets, Racks, Frames, and Enclosures

F. Section 27 15 13 - Communications Termination Blocks and Patch Panels

1.04 REFERENCES

A. Definitions:

1. AWG – American Wire Gauge – The standardized system for gauging the diameter of round, solid, non–ferrous, electrically–conducting wire.

2. BBC – Bonding Backbone Conductor – A telecommunication bonding connection which interconnects telecommunications bonding backbones. Formerly known as the grounding equalizer.

3. BN – Bonding Network – A set of interconnected conductive structures that provides a low impedance path for the associated telecommunications infrastructure.

4. EF – Entrance Facility – An entrance to a building for both public and private network service cables that includes the entrance point of the building and continues to the entrance room or space.

5. PBB – Primary Bonding Busbar – A busbar placed in a convenient and accessible location and bonded, by means of the Telecommunications Bonding Conductor (TBC), to the building's service equipment (power) ground. Formerly known as the Telecommunications Main Grounding Busbar (TMGB).

6. RBB – Rack Bonding Busbar – A busbar within a cabinet, frame, or rack.

7. RBC – Rack Bonding Conductor – A bonding conductor from the rack or Rack Bonding Busbar (RBB) to the Telecommunications Equipment Bonding Conductor (TEBC).

8. SBB – Secondary Bonding Busbar – A common point of connection for telecommunications system and equipment bonding to ground, located in the distributor room. Formerly known as the Telecommunications Grounding Busbar (TGB).

9. TBB – Telecommunications Bonding Backbone – The conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).

10. TBC – Telecommunications Bonding Conductor – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground. Formerly known as the Bonding Conductor for Telecommunications (BCT).

11. TEBC – Telecommunications Equipment Bonding Conductor – A conductor that connects the Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB) to equipment racks or cabinets.

12. TR – Telecommunications Room – An enclosed space for housing telecommunications equipment, cable terminations, and cross–connect cabling. It is the recognized location of the cross–connect between the backbone and horizontal facilities.

13. UBC – Unit Bonding Conductor – A bonding conductor from equipment or a patch panel to a Rack Bonding Conductor (RBB) or a Rack Bonding Busbar (RBB).

B. Reference Standards

1.	NFPA 70	-	National Electrical Code
2.	UL 467	-	Underwriters Laboratories. UL Standard No. 4 67, Electrical Grounding and Bonding Equipment.
3.	ANSI/TIA/EIA 607	-	Commercial Building Grounding and Bonding Requirements for Telecommunications.
4.	NECA/BICSI 607	-	Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial building
5.	BICSI TDMM	-	Telecommunications Distribution Methods Manual
6.	IEEE Standard 1100	-	Recommended Practice for Powering and Grounding Electronic Equipment (the Emerald Book).

1.05 DESCRIPTION

A. The telecommunications grounding system shall have a single point of attachment at the main electrical grounding electrode conductor. Other attachments to the system are made (to electrical service panels, cold water pipes, etc.), but those only

serve as supplemental connections and shall not be considered primary connections.

B. All ladder rack segments, conduits, pullboxes, junction boxes, equipment racks for use in support of the telecommunications infrastructure shall be bonded. All bonding and grounding shall terminate on the ground bar in each telecommunication room.

C. Busbars

1. The busbar at the entrance facility or the main electrical room shall be the PBB type. The PBB shall be connected to the electrical grounding system, and a PBB shall be required in all buildings.

2. The PBB shall be bonded to the electrical grounding system by an appropriately sized TBC.

3. All telecommunication equipment spaces require a SBB and for the SBB to be bonded to the PBB by the TBB.

4. All cable tray, equipment racks, and equipment cabinets shall be individually bonded to the SBB/PBB. All bonding connections shall be via the TEBC with a minimum No. 6 AWG size conductor.

5. All Telecommunication protectors and associated metallic cable sheaths to be grounded to selected SBB with a minimum 6 AWG insulated conductor.

D. Conductors

1. TBB conductors shall be sized based on length per TIA 607.

2. The TBC shall be equal in size to the TBB.

3. TBB conductors shall be continuous from the PBB to the farthest network room. Pigtails shall be used to connect the SBBs to the TBB. Pigtails shall attach to the TBB with irreversible compression connector (H-tap).

4. The TBB is not to be cut, with both ends bonded directly to the busbar. The end of the TBB farthest from the PBB may be bonded directly to the SBB.

1.06 QUALITY ASSURANCE

A. Grounding and bonding cables for Communication Systems shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, ANSI/TIA, BICSI, and the NEC.

B. NEC Compliance: Comply with NEC Chapter 8- Communications Systems.

C. UL Compliance: Provide products that are UL-classified and labeled.

D. NFPA Compliance: Comply with NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to Communications Systems”.

E. Manufacturer Qualifications: Firm specializing in manufacturing grounding and bonding cable with minimum five (5) years documented experience in production of similar products and equipment.

F. Installer Qualifications: Firm specializing in installing grounding and bonding cable with minimum three (3) years documented experience constructing systems of similar size and type.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for the grounding and bonding cable.
3. Scaled Shop Drawings showing proposed routing and layout of the grounding and bonding system.

B. Reports:

1. Field test reports shall be submitted.

C. Complete Bill of Materials.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Grounding and bonding equipment shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ground busbars shall be as manufactured by:

1. CPI Chatsworth Products, Simi Valley, CA;
2. Harger, Grayslake, IL;
3. Panduit, Tinley Park, IL;
4. Or approved equal.

B. Grounding accessories for racks shall be as manufactured by

1. CPI Chatsworth Products, Simi Valley, CA;
2. Panduit, Tinley Park, IL;
3. Or provided by manufacturer of the rack.
4. Or approved equal

C. Conductors

1. Southwire. Carrolton, GA;
2. Or approved equal

D. Connectors

1. Panduit, Tinley Park, IL;
2. Burndy, Norwalk, CT;
3. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Ground busbars (wall mount):

1. PBB:

a. Predrilled 10-32 holes for use with standard two-hole lugs. Hole patterns for attaching grounding two-hole lugs shall meet the requirements of BICSI and ANSI/TIA 607.

b. Rectangular bars of hard-drawn, tin plated, solid copper, with minimum dimensions of ¼ inches thick by 4 inches wide, 20 inches in length or as indicated on Contract Drawings.

c. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 2.5 inches standoff from the wall.

d. The busbar shall be UL listed for use as a PBB.

2. SBB:

a. Predrilled 10-32 holes for use with standard two-hole lugs. Hole patterns for attaching grounding two-hole lugs shall meet the requirements of ANSI/TIA 607.

b. Rectangular bars of hard-drawn, tin plated, solid copper, with minimum dimensions of ¼ inches thick by 2 inches wide, 12 inches in length or as indicated on Contract Drawings.

c. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 2.5” inches standoff from the wall.

d. The busbar shall be UL listed for use as a SBB.

B. Grounding Accessories for racks:

1. Ground busbars:

a. Provide a tinned copper busbar to serve as an extension of the PBB or SBB for the equipment in the rack.

b. Shall be manufactured from copper alloy.

c. Horizontal Busbars shall be at least .75 inches wide, 19 inches or 23 inches long, and 0.1875 inches thick.

d. Have at least 14, factory-provided tapped ground mounting holes.

e. If required, each horizontal busbar shall include a copper splice bar of the same material (to transition between adjoining racks) and copper-plated steel screws and flat washers for attachment to the rack..

f. Vertical busbars shall be at least 0.67 inches wide, 78.65 inches long, and 0.25 inches thick and come in threaded rail and cage nut versions.

g. Include a hardware kit with rack installation hardware and with screws for bonding equipment to the busbar.

h. Horizontal and vertical busbars shall be UL listed.

2. Unit Bonding Conductor Jumper Kit:

a. UBC shall be #6 AWG stranded copper conductor with green insulation and a horizontal yellow strip.

b. Install UBC between each shielded patch panel or equipment and the rack bonding element (vertical or horizontal rack busbars).

c. Each UBC shall have two-hole compression lugs at each end and be available in in 6 inch length increments.

d. The kit shall include a packet of antioxidant joint compound.

3. Rack Bonding Conductor Jumper Kit:

a. RBC shall be #6 AWG stranded copper conductor with green insulation and a horizontal yellow strip.

b. Secure one end of the jumper to the TEBC or to a bonding busbar and the other end (terminated with a two hole lug) to the rack.

c. Kit shall include all mounting hardware to attach to the rack.

C. Conductors:

1. The TBC shall be UL listed, stranded conductor insulated with a green jacket. The TBC shall be equal in size to the TBB specified in this Section.

2. The TBB shall be UL listed, stranded conductor insulated with a green jacket with a minimum conductor size of #6 AWG and sized at 2 kcmil per linear foot up to a maximum size of 750 kcmil.

3. Shall meet the requirements of Section 26 05 20- Low-Voltage Wires, Cables, and Accessories.

D. Connectors:

1. Compression lugs:

a. Compression lugs shall be manufactured from electroplated tinned copper.

b. Compression lugs shall have two holes spaced on 5/8" or 1" centers to allow secure two bolt connections to busbars.

c. Compression lugs shall be sized to fit a specific size conductor.

d. Compression lugs shall have a long barrel to maximize number of crimps and to provide premium wire pull-out strength and electrical performance.

e. Compression lugs shall be UL listed.

2. C-Type Compression Taps:

a. Used as a splice, or to tap smaller (pigtail) conductors into larger continuous conductors.

b. Compression taps shall be manufactured from copper alloy.

c. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation shall require a hydraulic crimping tool.

d. Compression taps shall be sized to fit specific size conductors.

e. Compression taps shall be UL listed.

3. H-Type Compression Taps:

a. Used as a splice, or to tap smaller (pigtail) conductors into larger continuous conductors.

b. Each tap shall be able to terminate a wider range of conductor sizes.

c. Compression taps shall be manufactured from high-conductivity, extruded copper and electro-tin plated.

d. Compression taps shall be H-shaped connectors that wrap around multiple conductors forming an irreversible splice around the conductors; installation shall require a hydraulic crimping tool.

e. Compression taps shall be sized to fit specific size conductors.

f. Compression taps shall be UL listed.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

B. Contractor shall submit Certificate of Calibration of all test instruments.

3.02 INSTALLATION

A. Bonding for telecommunication systems relies on short direct paths that have minimum resistive and inductive impedance. Installation of conductors shall be the following:

1. Bonding conductors shall be routed with minimum bends or changes in direction.
2. Bonding connections shall be made directly to the points being bonded.
3. Unnecessary connections or splices in bonding conductors shall be avoided, but, when necessary, use an approved connection and position it in an accessible location.
4. Structural steel, used as lightning down-conductors, shall not be used as a TBB.
5. Conductors shall be run from the Entrance Facility busbar to structural steel within the same room or one within close proximity. Bonds to structural steel shall be exothermic welds. Vertical structural steel used as lightning down-conductors shall not be bonded to the telecommunications bonding system. In this instance, other structural steel (e.g. horizontal members) may be bonded to the Entrance Facility busbar.
6. Conductors shall have grounding equalizers as required by BICSI methodologies for multiple TBBs.
7. The Contractor shall label all elements of the communications bonding network according to guidelines define in ANSI/TIA/607 and ANSI/TIA/606.
8. Connections (bonds) between the telecommunications grounding network and associated electrical equipment shall be done a by qualified electrician in accordance with guidelines in ANSI/TIA-607 and applicable electrical codes.

9. Routing grounding conductors through ferrous metal conduit should be avoided, but if it is necessary due to building constraints, any grounding conductor running through ferrous conduit longer than 3 feet shall be bonded at the end using appropriately sized H-type compression tap and conduit grounding clamps as described in ANSI/TIA 607.

10. Conductors used to bond TBB to conduit ends shall be of #6 AWG size or larger.

11. PBB shall be sized according to the anticipated number of bonded connections needed.

3.03 FIELD TESTING / QUALITY CONTROL

A. Final field tests shall be performed for all grounding and bonding systems provided under this Specification, as specified in Article 13 of the General Conditions and Section 01 75 10 – Preliminary and Final Field Tests.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, and equipment to install a complete communications network as shown on the Contract Drawings and specified herein.

B. The communications network wiring shall be the Structured Cabling System (SCS) type for fiber optic and copper cables.

C. The Contractor shall obtain the services of a Structured Cabling Installer (SCI), who shall furnish all materials, equipment, labor, and services required to achieve a fully wired and operational communications system as specified herein and shown in the Contract Drawings.

D. The installation shall be an "Open System" using standard equipment.

E. The following index of this Section is presented for convenience:

F.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 26 05 11	-	General Electrical Requirements
B.	Section 26 05 27	-	Grounding
C.	Section 26 05 53	-	Identification for Electrical Systems
D.	Section 27 05 26	-	Grounding and Bonding for Communication Systems
E.	Section 27 11 19	-	Communications Termination Blocks and Patch Panels

1.04 REFERENCES

A.	NFPA 70	-	National Electrical Code
B.	TIA-526-7-A	-	Measurement of Optical Power Loss of This standard specifies singlemode optical loss measurement methods between two passively connected points using an optical source and power meter.
C.	ANSI/TIA-568.0	-	Generic Telecommunications Cabling for Customer Premises
D.	ANSI/TIA-568.1	-	Commercial Building Telecommunications Cabling Standard
E.	ANSI/TIA-568.2	-	Balanced Twisted-Pair Telecommunications Cabling and Components Standard
F.	ANSI/TIA-568.3	-	Optical Fiber Cabling Components Standard
G.	ANSI/TIA-568.4	-	Broadband Coaxial Cabling and Components Standard.
H.	ANSI/TIA-569	-	Telecommunications Pathways and Spaces
I.	BICSI TDMM	-	Building Industries Consulting Services International (BISCI0 Telecommunications Distribution Methods Manual (TDMM)
J.	ANSI/TIA/EIA 606	-	Administration Standard for the Telecommunications Infrastructure
K.	ICEA S-104-696	-	Standard for Indoor-Outdoor Optical Fiber Cable
L.	ANSI/NECA/BICSI N1		American National Standards Institute/National Electrical Contractors Association/Building Industry Consulting Services International, Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
M.	ANSI/TIA/EIA 598	-	Optical Fiber Cable Color Coding

N. ANSI/TIA/EIA - 604 Fiber Optic Connector Intermateablility Standard (FOCIS)

1.05 DESCRIPTION

A. General Requirements:

1. The design of the SCS for the Electrical building Local Area Network (LAN) and modifications to the existing SCS of Lower Effluent Chamber (LEC) shall be done by the SCI.

2. The SCI shall provide the Electrical building's LAN system as a completely cabled and terminated network communication system and connected to the EOH Headquarters' main Ethernet network switch.

3. The SCI shall modify the LEC's LAN system to accommodate the new network equipment and the modifications shall include new cabling and terminations.

4. System cabling, raceways, pathways, and spaces shall at a minimum comply with the latest ANSI/TIA/EIA 568, 586, 569, and 607 standards.

5. Unless otherwise specified, provide cabling as recommended by the manufacturer.

6. Terminate all network cables and wiring according to manufacturer recommendations. All cabling and wires shall be neatly bundled and secured. All terminations shall be labeled.

7. All network connections coming from or traversing outside a lightning protected structure shall be surge protected. Provide Surge Protection Devices (SPD) for each conductor that originates or traverses from inside to outside of a building or outside to inside of a building.

8. The SCS shall be grounded and bonded per the latest ANSI/TIA/EIA-607, NFPA 70, and UL 467 standards.

1.06 QUALITY ASSURANCE

A. SCI:

1. The SCI shall be a certified installer for the connectivity and cabling solution specified for this project and maintain that status with the warranting manufacturer, including all training requirements, for the duration of the project.

B. SCI Qualifications:

1. The SCI shall be a financially sound and experienced firm having at least 5 (5) years continuous experience in designing, implementing, and installing SCSs, which are comparable in size and complexity as required for this project.

2. The SCI shall have in existence at the time of bid advertisement, an experienced technical staff capable of designing, implementing, and installing a SCS and handling SCS submittals and training requirements.

3. The SCI shall have successfully completed the layout, installation, testing and warranty of not less than five SCSs similar to the scope of this project.

4. The SCI shall have Installer-level BICSI Certification.

C. SCI Responsibility:

1. The Contractor shall retain the SCI to assume the responsibilities specified below. However, execution of these specified duties by the SCI shall not relieve the Contractor of the ultimate responsibility for the SCS.

a. Design, implementation, and installation of the SCS and all subsystems in accordance with the Contract Documents and all referenced standards and codes.

b. Preparation, assembly, and correction of all SCS submittals in accordance with the Contract Documents.

c. Proper interfacing of the SCS equipment.

d. Supervision of the installation of SCS and other components required.

e. Handling of all warranty obligations for the SCS.

D. Coordination and Progress meetings:

1. The Contractor shall be responsible for the scheduling and coordinating the SCS installation with regard to all other work on the site and in accordance with the provisions of the General Conditions. Said coordination shall be documented on the project schedule.

2. Routine progress and coordination meetings will be scheduled by Engineer. The Contractor and a representative of the SCI shall be required to attend a minimum of one meeting per month for the length of Contract.

3. The purpose of the meetings shall be to review the progress of the work involving the SCS and provide coordination for installation of the equipment to ensure construction schedules are met.

4. Representatives at the meetings shall have the competence and authority to make any and all necessary decisions. Decisions and statements made at the meetings shall commit the Contractor and the SCI to agreed procedures and schedules.

E. SCI Project Personnel:

1. The Contractor shall require the SCI to provide the following project personnel:

a. BICSI Registered Communications Distribution Designer (RCDD)

1) The SCI shall have as a direct employee, a BICSI Registered Communications Distribution Designer (RCDD) on staff. The RCDD must be a full-time employee of the company and must be listed with the company on the BICSI Credential Holder website.

2) The RCDD shall be thoroughly experienced in the design, layout, and installation of SCSs of similar size and complexity as required for this installation.

3) The RCDD shall have a minimum of five (5) years design experience under this credential.

4) The SCI's RCDD shall have overall responsibility for certifying that the installed SCS confirms to the Contract Documents and to the referenced EIA/TIA, IEEE, BICSI, and UL standards.

5) The RCCD shall develop the field testing procedures for all copper and fiber optic cables.

6) The RCDD shall be thoroughly experienced in the design, layout, and installation of SCSs. The RCDD shall submit evidence of these qualifications to the Engineer upon request.

1.07 SUBMITTALS

A. Shop Drawings General:

1. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer.

2. Shop Drawing preparation shall not commence until after the pre-submittal conference specified below.

3. Installation of the SCS shall not commence until related and interfacing equipment submittals have been approved by the Engineer.

4. Shop Drawings shall be submitted in complete packages grouped to permit review of related items as generally outlined in this Section under Submittal Requirements.

5. Review of Shop Drawings will be for conformance with Contract Documents and regarding functions specified to be provided.

6. Preparation of all Shop Drawings shall be under the direct supervision of the RCDD. Affixed to all Shop Drawings shall be the RCDD's stamp.

B. Pre-Submittal Conference:

1. The Contractor shall arrange and conduct a pre-submittal conference on the SCS within forty-five (45) days of notification of preliminary acceptance of the proposed SCI by the City and the Engineer.
2. The Pre-submittal conference shall be attended by representatives of Contractor, the SCI and the Engineer. The Contractor shall allocate one (1) full working day for the conference and that time shall be included in the price of this Contract. The meeting shall be held at Kensico or at a location approved by the Engineer.
3. The purpose of the pre-submittal conference shall be to review informally and approve the manner in which the SCI intends to respond to the Contract requirements before any submittals are prepared.
4. Contractor shall prepare the items listed below for presentation at the pre-submittal conference. The information shall be submitted to Engineer four (4) working weeks prior to the date of the conference.
    a. List of equipment and materials required for the SCS and the brand and model which Contractor proposes to use for each item or component of the proposed system.
    b. List of proposed exceptions to the plans and Specifications along with a brief explanation of each.
        1) Approval of exceptions and substitution shall be subject to a formal submittal according to the Contract procedure.
    c. Sample of each type of submittal specified herein. These may be submittals prepared for other projects.
    d. A flow chart showing the steps to be taken in preparing and coordinating each control system submittal to the Engineer, and a list of proposed submittals.
    e. Schedule for all SCS related activities from the pre-submittal conference through start-up and training.
        1) Particular emphasis shall be given to dates relative to submittal, design, fabrication, delivery, installation and field testing.
        2) The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.
        3) Schedule shall conform to requirements for Contract schedules.

C. Product Data:

1. Provide engineering data sheets, product literature, and similar information on each component including part numbers of the various components.

a. Fiber optic cable, patch cables and termination devices.

b. Copper cable, patch cables and termination devices.

c. Patch panels and accessories.

d. Grounding components.

D. Shop Drawings:

1. Layout Responsibility: Drawings complete with wiring diagrams and details to show that the SCS shall properly support connectivity from the MDF to the IDF to the telecommunications work area. Show the layout of cabling and pathway runs in the MDF and IDF and ground system.

2. Provide detailed scaled drawings showing proposed routing and layout of the SCS. Detailed plans to include rack elevations and placement of equipment in each room. Drawings shall depict telecommunications cabling configuration, including location, gauge, pair assignment and patch panels.

3. Backbone cable distribution plan between buildings.

4. Specific cable routing paths for main cabling trunks, supports (such as J-Hooks, D-Hooks), conduits and junction boxes.

5. Submit a complete one-line riser diagram showing all equipment, cable and outlets identified with part numbers and cable identification.

6. Wiring diagrams for all installed cabling.

7. Submit a certificate with the RCDD signature, registration number, and seal verifying the completeness and accuracy of the design.

8. Complete Bill of Materials.

9. Nameplate schedules.

10. Recommended spare parts list.

E. SCS Operation and Maintenance (O&M) Manuals.

1. The Contractor shall furnish O&M manuals for the SCS in accordance with the Section 01 78 25 – Operation and Maintenance Manuals, this Section and the following minimum requirements:

a. Complete list of supplied SCS hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.

b. Copy of all approved submittal information and system shop drawings as specified herein with corrections made to reflect actual system as tested and delivered to the site for installation.

c. Half-size black line reproductions shall be provided for all shop drawings larger than 11 by 17 inches.

d. All drawings shall be 11 by 17 inches minimum size.

1) Drawings 8-1/2 by 11 inches are not acceptable.

e. Manuals shall include the following information:

1) General descriptive information covering the basic features of the equipment.

2) Physical description covering layout and installation requirements and all environmental constraints.

3) Maintenance procedures covering checkout, troubleshooting, and servicing.

a) Checkout procedures shall provide the means to verify the satisfactory operation of equipment,

b) Troubleshooting procedures shall serve as a guide in determining faulty components.

c) Servicing procedure shall cover requirements and recommended time schedule for calibration, cleaning, lubrication and other housekeeping and preventive maintenance procedures.

4) Safety considerations relating to operation and maintenance procedures.

F. Record Drawings and Documentation

1. The Contractor shall require the System supplier to revise all system shop drawings, submittals to reflect as-built conditions in accordance with the requirements of the Contract Documents and the supplemental requirements.

2. All revised shop drawings and documentation shall be submitted to the Engineer per Section 01 78 40 – Final Record Documents to replace outdated drawings and documentation contained in the system O&M Manuals.

3. Half-size black line sets shall be provided for all drawings larger than 11 x 17. Specific instructions for outdated drawing removal and replacement shall be provided with the record drawing submittal.

4. Half-size black line prints of wiring diagrams applicable to each control panel shall be provided inside a clear plastic envelope and stored in a suitable print pocket or container inside each control panel.

5. The as-built drawings submitted by the Contractor shall be stamped by the RCDD indicating that the RCDD has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.

G. Reports.

1. All Shop and Field Test Reports.
2. All Manufacturer's site visit and Acceptance Testing Reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. SCS equipment shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools, and supplies with the structured cabling equipment, neatly wrapped, or boxed, indexed, and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ladder Rack shall be as manufactured by:

1. CPI Chatsworth; Simi Valley, CA
2. Belden; St. Louis, MO
3. TrippLite; Chicago, IL
4. Or approved equal.

B. J-Hook shall be as manufactured by:

1. Cooper B-Line,
2. Erico, type Cable Cat 21 and 32,
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Ladder Rack:

1. Provide telecommunications room with ladder racks or wire mesh cable trays as required. Fasten ladder racks or cable tray to racks.
2. Ladder rack shall be manufactured from tubular steel. Stringers (side rails) shall be 1.5 inches deep. Maximum fill is equivalent to TIA recommended maximum fill of 6 inches deep. Provide accessory cable retaining posts if cable fill height exceeds 2 inches. Where cable retaining posts are used, they shall be 8 inches high and shall attach to the side stringer of the ladder

rack with included hardware. The top of the cable retaining posts shall be fitted with a rubberized end cap to protect cables.

3. Ladder rack width shall be 12 inches with cross member (rung) spacing on 9 inch centers.
4. All cross members shall be welded into position for maximum strength and electrical continuity of elements. No cross members shall protrude below side members that would interfere with supporting structures.
5. All straight sections shall be provided in standard 10-foot nominal sections.
6. Provide a method of splicing ladder rack sections and fabricated turns together end-to-end or side-to-end to form a continuous pathway.
7. Vertical-to-horizontal and horizontal-to-vertical 90-degree turns shall be provided as required.
8. Ladder rack supports shall be of the trapeze type. Supports shall be sized to match the width of the ladder rack that is supported. Support design shall allow the support to be placed under the ladder rack at any point mid-span, but not under a ladder rack splice.
9. All ladder rack elbows, tees, and cross fittings shall be furnished in a radius of 12, 24, or 36 inches in 30, 45, 60, or 90 degrees of arc as necessary to meet the NEC and BICSI bending radius limitations of cables to be installed in the trays. Using straight runs with radius corner brackets is also acceptable.
10. Dropouts shall be steel sheets with round radius attached to either side of the stringer or cross member to permit cable exit out of bottom of cable tray. Where cable exits or enters the side of overhead ladder rack to access a rack, enclosed rack or wall-mounted rack, cabinet or termination field, a radius drop shall be used to guide the cable.
11. End caps shall be provided to cover the ends of the ladder rack. End caps shall be manufactured from a black fire-retardant rubberized material.
12. Cable straps used for attaching cable bundles to the ladder rack cross members must be reusable with a hook and loop-style closure, at least 3/4 inch wide, and sized for cable bundles that are 2 inches, 3 inches, or 4 inches in diameter.
13. Finish on all metal components shall be black epoxy-polyester hybrid powder coat.
14. Separate different cable media types within the ladder rack pathway. Treat each type of cable media separately when determining cable fill limits.
15. Provide touch-up paint color-matched to the finish on the component and correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the Owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.

B. J-Hooks

1. J-Hooks
   a. J-hooks shall be at least 1-inch hook size, minimum and shall not be over 4-inch hook size.
   b. Made of high-quality,18 gauge galvanized steel and zinc plated.
   c. Accommodate CAT 6A and fiber optics cables.
   d. May utilize multi-tier configuration.
   e. J-hooks shall have no sharp edges.
   f. Threaded rods are to be used for J-hook support where required.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Copper Cabling

1. Copper horizontal cabling shall be as specified in Section 27 15 13 – Communications Copper Horizontal Cabling.

2. Copper patch cables shall be as specified in Section 27 16 19 – Communications Patch Cords, Stations, and Cross Connect Wire.

B. Fiber Optic Cabling

1. Fiber optic cables for inter-building connections shall be as specified in Section 27 13 23 – Communications Optical Fiber Backbone Cabling.

2. Fiber optic patch cords shall be as specified in Section 27 16 19 – Communications Patch Cords, Stations, and Cross Connect Wire.

C. Patch Panels

1. Copper and fiber patch panels shall be as specified in Section 27 11 19 – Communications Termination Blocks and Patch Panels.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

B. Coordinate the installation of the SCS with the other work of this project. The Contractor shall ensure that construction and preparation of the rooms and spaces in which the work of this Section are to be installed are sufficiently complete before beginning work.

3.03 FIELD TESTING / QUALITY CONTROL

A. Upon completion of the Category 6Acable installation, the SCI shall perform field tests as described in Section 27 15 13.

B. Field testing shall be performed to published standards, including but not limited to, the latest revisions of ANSI/TIA 568, ISO/IEC 11802 and other applicable standards at the time of installation.

C. All Category 6A field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided to the Engineer for review prior to the start of testing.

D. Final field tests shall be performed for all communication equipment provided under this Specification, as specified in Article 13 of the General Conditions and Section 01 75 10 – Preliminary and Final Field Tests.

E. Upon completion of the fiber optic cable installation, the SCI shall perform field test as described in Section 27 13 23

F. In addition to any specific tests mentioned here, the SCI shall perform all required testing and documentation to obtain a fully certified installation from the manufacturer.

G. The RCDD shall sign off on all copper and fiber optic cable test results, indicating that all cables were tested in compliance with the Contract Documents.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, as specified, and required to furnish, install, and place into satisfactory operation all communications cabinets, racks, frames, and enclosures and all associated equipment, as indicated on the Contract Documents.

B. Contractor shall furnish and install cable management and cable raceways as per the Contract Documents.

C. All miscellaneous equipment and labor to install cable raceways, radius drops, etc. shall be included. Cable runway radius drops should be provided for each of the racks in each of Telecommunications and Equipment Room(s).

D. The following index of this Section is presented for convenience:

E.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 26 05 11	-	General Electrical Requirements
B.	Section 26 05 29	-	Hangers and Supports for Electrical Systems
C.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems
D.	Section 26 05 48	-	Vibration and Seismic Controls for Electrical Systems
E.	Section 26 05 53	-	Identification for Electrical Systems
F.	Section 27 05 26	-	Grounding and Bonding for Communication Systems

1.04 REFERENCES

A.	NFPA 70	-	National Electrical Code
B.	ANSI/TIA/EIA 607	-	Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises
C.	ANSI/EIA-310	-	Racks, Panels, and Associated Equipment
D.	UL 1863	-	Standard for Communications-Circuit Accessories
E.	UL 2416	-	Audio/Video, Information and Communication Technology Equipment Cabinet, Enclosure and Rack Systems
F.	NEMA 250	-	Enclosures for Electrical Equipment

1.05 DESCRIPTION

A. The racks shall be the enclosed or open type as shown on the Contract Drawings.

B. The number of racks shall be as shown on the Contract Drawings.

C. All enclosed racks shall be equipped with adjustable rails, removable top panels and locking removable side panels.

D. All racks shall have vertical and horizontal cable management provisions.

E. All cabinets, racks, frames, and enclosures installation shall comply with Section 26 05 48 – Vibration and Seismic Control for Electrical Systems and applicable seismic requirements of the NYCBC.

1.06 QUALITY ASSURANCE

A. Communication cabinets, racks, frames, and enclosures shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, ANSI/TIA, ANSI/EIA and the NEC.

B. The rack manufacturer shall be the manufacturer of all the major components of the racks as specified in this Section, the Specifications and as shown on the Contract Drawings.

C. The rack manufacturer shall have produced racks for a minimum period of the last continuous five (5) years.

D. The rack manufacturer shall maintain a documented Quality Assurance Program implementing suitable procedures and controls to monitor all aspects of production and testing.

1. The Quality Assurance Program shall be the manufacturer's standard program specifically dedicated to ensuring that each rack and its components are designed, assembled and tested in accordance with the requirements specified in this Section, the Specifications and the Contract Drawings.

E. Racks shall be UL listed.

F. Seismic Requirements

1. The Contractor shall provide racks designed, constructed and installed suitable for earthquake regulations in accordance with the seismic requirements of Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems and the NYCBC.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for approval by the Engineer.

B. Submittals shall include, but not be limited to the following:

1. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for the racks.

2. Certified dimensioned outline drawings showing rack layouts, front view, and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.

3. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.

4. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as cable trays, cable runway, radius drops, cables, conduit, etc.

5. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.

6. Erection drawings and procedures.

7. Complete Bill of Materials.
8. Details of special features
9. Nameplate schedules.
10. Painting Procedures.
11. Operation and Maintenance manuals.
12. Certificates of Compliance/Manufacture: Seismic qualification certification from the manufacturer including mounting recommendations.
13. Reports:
    a. Shop and field test reports shall be submitted.
    b. Acceptance testing report shall be submitted.
14. Seismic Requirements
    a. Calculations demonstrating compliance with Section 26 05 46 – Vibration and Seismic Controls for Electrical Equipment and NYCBC.
    b. Rack anchorage details with design calculations signed by a NYC Licensed Engineer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Racks shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications and the following:

1. Racks shall be inspected when received, for shipping damage, water intrusion which may have entered the equipment during transit or loose parts and a report of any damage made to the carrier within the specified time.
2. Racks shall be inspected when received, for shipping damage, water intrusion which may have entered the equipment during transit or loose parts and a report of any damage made to the carrier within the specified time.
3. Racks shall be stored indoors in a well-ventilated, clean, level, dry and cool location with uniform temperature to prevent condensation.
4. Racks shall be protected in storage with suitable covering and air circulation maintained to ensure the equipment is kept dry and free from condensation.
5. Where dampness or condensation may be encountered, heaters shall be provided for equipment to prevent moisture damage.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Resident Engineer, at that part of the site and at such time as the Resident Engineer may direct, spare parts for the communication cabinets, racks, frames, and enclosures.

B. The Contractor shall furnish for the racks, all spare parts, special tools and supplies as recommended by the manufacturer.

C. The spare parts, special tools and supplies shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Open Frame Network Rack shall be as manufactured by:

1. CPI Chatsworth Products, Simi Valley, CA;
2. Great Lakes (Data Racks and Cabinets), Edinboro, PA;
3. Belden, St. Louis, MO
4. Or approved equal.

B. Network Rack Enclosures shall be as manufactured by:

1. Great Lakes (Data Racks and Cabinets), Edinboro, PA;
2. Belden, St. Louis, MO;
3. Or approved equal.

C. Network Rack Enclosures (NEMA) shall be as manufactured by:

1. Rittal, Chicago, IL;
2. Great Lakes (Data Racks and Cabinets), Edinboro, PA;
3. Belden, St. Louis, MO;
4. Or approved equal.

D. Network Rack Enclosures (NEMA – Wall Mounted) shall be as manufactured by:

1. Great Lakes (Data Racks and Cabinets), Edinboro, PA;
2. CPI Chatsworth Products, Simi Valley, CA;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Open Frame Network Racks

1. Construction (Four-Post):

a. Vertical upright channels, top and base depth angles shall be constructed of #12 gauge cold rolled steel.

b. Top and base angles shall be constructed of #7 gauge cold rolled steel.

c. Vertical channel to be 3" deep with networking side facing holes.

d. Equipment Mounting: Adjustable 19" EIA mounting rails with 3/8" square holes for metric 6mm cage nut hardware. Each mounting space shall be marked and numbered on the mounting channel.

e. Grounding: Include main bonding 2-hole lug.

f. Static Load Capacity: at least 1,500 lbs.

g. Finish: RAL9005 black powdered finish

2. Cabinet Dimensions:

a. Height: Height in Rack Mounting Units (RMUs), as shown in Contract Drawings

b. Width: 23.3" inches

c. Depth: 41.5" inches

B. Network Rack Enclosures

1. Cabinet Construction:

a. The enclosure shall be constructed of cold rolled steel utilizing a fully welded steel frame and doors.

1) Welded Frame #14 gauge minimum

2) (2) two pair mounting rails #13 gauge minimum

3) Top panel #18 gauge minimum

4) Doors and side panels #22 gauge minimum

b. Front door: perforated door mesh vented with keyed locking handles.

1) Concealed lift off hinge type, with bonding wire and quick disconnect

2) Handle cut out, 25mm x 150 mm.

c. Rear doors: perforated door mesh vented with keyed locking handle.

1) Concealed lift off hinge type, with bonding wire and quick disconnect

2) Handle cut out, 25mm x 150 mm.

d. Side panels: Each with a keyed lock.

e. Top panel: Provisions for optional fan tray and cable access cut out.

f. Equipment Mounting: Adjustable 19" EIA mounting rails with 3/8" square holes for metric 6mm cage nut hardware. Each mounting space shall be marked and numbered on the mounting channel.

g. Grounding: Grounding studs on the frame, side panels, and doors.

h. Static Load Capacity: 3,000 lbs (2,250 lbs on capacity casters)

i. Enclosure Finish: RAL9005 black powdered finish

2. Cabinet Dimensions:

a. Height: Height in RMUs, as shown in Contract Drawings

b. Width: 30" inches

c. Depth: 42" inches

C. Network Rack Enclosures (NEMA)

1. Cabinet Construction:

a. The enclosure shall be constructed of cold rolled steel utilizing a fully welded steel frame and doors.

1) Welded Frame #14 gauge minimum

2) (2) two pair mounting rails #12 gauge minimum

3) Top panel #18 gauge minimum

4) Doors and side panels #14 gauge minimum

b. Front door: tempered safety glass front door with three-point latching system and gasketed gland plates

c. Rear door: solid with three-point latching system and sealed gland plates

d. Sealed gland plates: removable and can be replaced with fan kits.

e. Side panels: Each with a cam lock

f. Top panel: Provisions for optional fan tray and cable access cut out

g. Sealing: Formed in place foam gaskets

h. Equipment Mounting Rails: Adjustable 19" EIA mounting rails with 3/8" square holes for metric 6mm cage nut hardware. Each mounting space shall be marked and numbered on the mounting channel.

i. Grounding: Grounding studs on the frame, side panels, and doors.

j. Static Load Capacity: 1,500 lbs minimum

k. Enclosure Rating: NEMA 12

l. Enclosure Finish: RAL9005 black powdered finish

2. Cabinet Dimensions:

a. Height: Height in RMUs, as shown in Contract Drawings

b. Width: 30"inches

c. Depth: 42"inches

D. Wall Mounted Network Rack (NEMA)

1. Cabinet Construction:

a. The enclosure shall be constructed of cold rolled steel utilizing a fully welded steel frame and doors.

1) Welded frame #14 gauge

2) (2) two pair mounting rails #12 gauge minimum

3) Doors and side panels #14 gauge minimum

b. Front door: tempered safety glass front door with three-point latching system

c. Rear section: solid metal chassis with provisions to mount on the wall and with top and bottom conduit openings.

d. Center section: solid metal chassis that hinges open and vented sides with provisions for fan assembly.

e. Sealing: formed in place foam gaskets

f. Equipment Mounting Rails: Adjustable 19" EIA mounting rails with 3/8" square holes for metric 6mm cage nut hardware.

g. Grounding: Grounding studs on the frame, side panels, and doors.

h. Static Load Capacity: 110 lbs minimum

i. Enclosure Rating: NEMA 12

j. Enclosure Finish: RAL9005 black powdered finish

2. Cabinet Dimensions:

a. Height: Height in RMUs, as shown in Contract Drawings.

b. Width: 24” inches

c. Depth: 24” inches

E. Network Rack Accessories

1. All racks shall be provided with the following accessories:

a. Vertical Power Distribution Units:

1) Electrical: 20A-120V

2) Receptacle type: NEMA 5-15R

3) 10 outlets with surge protection

4) On-Off switch

5) Dual input and manual bypass

b. Horizontal Cable Management:

1) 4” front ring depth

2) Metal panel with plastic rings

3) Front cover

4) Pass-thru holes from front to rear

c. Vertical Cable Management:

1) 4” wide x 6” deep

2) Cold rolled steel with flexible rings

d. Rack Mount Uninterruptible Power Supply

1) Size and battery backup/run time as indicated on the Contract Drawings

2) With an external maintenance bypass switch

2. For free standing network racks, a rack-mounting kit shall be provided for securing racks to a concrete slab floor.

3. Horizontal or vertical busbars per Specification Section 27 05 26 – Grounding and Bonding for Communications Systems.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Painting shall be in accordance with Section 09 91 90 – Painting.

B. All internal and external metal surfaces of the racks shall be thoroughly cleaned, rinsed, and phosphatized prior to painting.

C. A supply of touch-up paint shall be provided from paint used for the final coat.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

B. Anchor racks to satisfy the specified seismic requirements in accordance with the anchorage details.

C. Install nameplates for identification of all racks.

D. All floor supported racks shall be bolted to the structure in accordance with the requirements of the New York State Building Codes and the Contractor's approved structural engineering submittal demonstrating the method to be used to conform to these requirements.

E. Wall mounted racks shall similarly be bolted to structural members in accordance with the requirements of the New York State Building Codes and the Contractor's approved structural engineering submittal demonstrating the method to be used to conform to these requirements.

3.02 INSTALLATION

A. Racks shall be secured and grounded per manufacturers and all applicable codes.

B. Anchor racks in accordance with Section 26 05 48 – Vibration and Seismic Controls for Electrical Equipment and the NYCBC.

C. Racks shall be fastened with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on metal

D. All cables shall be neat within the racks. Cables shall be run vertically using the vertical cable managers and horizontally using the horizontal cable managers.

E. Install nameplate for rack identification.

F. Racks shall be positioned a minimum 4' from any wall in front of or behind it and minimum of 3' from the side of the rack to the wall.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install Communications Termination Blocks and Patch Panels and all other appurtenant requirements.

B. Provide patch panels in sizes and quantities as required to support all cables to be terminated. The sizes and quantities shown on the Contract Drawings are for representative purposes only and may or may not be the final sizes and quantities required.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A.	Section 26 05 11	-	General Electrical Requirements
B.	Section 26 05 27	-	Grounding
C.	Section 26 05 29	-	Hangers and Supports for Electrical Systems
D.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems
E.	Section 26 05 53	-	Identification for Electrical Systems
F.	Section 27 11 16	-	Communications Cabinets, Racks, Frames, and Enclosures.
G.	Section 27 13 23	-	Communications Optical Fiber Backbone Cabling

1.04 REFERENCES

A.	ANSI/EIA-568.1	-	Commercial Building Telecommunications Cabling Standard
B.	ANSI/TIA-568.2	-	Balanced Twisted-Pair Telecommunications Cabling and Components Standards
	ANSI/TIA-568.3	-	Optical Fiber Cabling Components Standard
C.	ANSI/TIA/EIA 607	-	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
D.	UL 467	-	UL Standard for Safety Grounding and Bonding E Equipment
E.	IEEE 802.3ab	-	1000Base-T Ethernet
F.	IEEE 802.3an	-	10GBase-T Ethernet

1.05 DESCRIPTION

A. Rack mount and wall mount patch panels shall house, organize, manage, and protect fiber optic and Ethernet cable.

B. Patch panels shall accommodate all trunk cables, connectors, patch cords, and adapter plates

C. Patch panels shall accommodate both field termination and field splicing.

1.06 QUALITY ASSURANCE

A. Communications patch panels shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, ANSI/TIA, and the NEC.

B. NEC Compliance: Comply with NEC Chapter 8- Communications Systems.

C. UL Compliance: Provide products that are UL-classified and labeled.

D. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to Communications Systems".

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for the patch panel.
3. Certified dimensioned outline drawings showing equipment layouts, front view, and floor plan in sufficient detail to define space required for dismantling and maintenance, exact location of and space available for conduit entrance and the interrelationship of the various components.
4. Cross sections and details, as required, to satisfy the Engineer, that all components conform with specification requirements, including design and physical arrangement.
5. All information required by the Engineer for the design and location of all connecting structural, mechanical, or electrical items such as piping, ducts, cables, conduit, etc.
6. Weight of the equipment and distribution on the foundation support of the static, impact, wind, and other loads.
7. Complete Bill of Materials.
8. Nameplate Schedules.
9. Operation and Maintenance manuals.

B. Reports:

1. Shop and field test reports shall be submitted.
2. Acceptance testing report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Communications Termination Blocks and Patch Panels shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the Engineer, at that part of the site and at such time as the Engineer may direct, spare parts for the Communication Termination Blocks and Patch Panels.

B. Spare parts shall be as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Communications Termination Blocks shall be manufactured by:

1. Tii Technologies, Edgewood, NY;
2. Or approved equal.

B. Copper Patch Panels shall be manufactured by:

1. Commscope, Hickory, NC;
2. Signamax. Miami, FL;
3. Or approved equal.

C. Fiber Patch Panels (Rack Mount) shall be manufactured by:

1. Siemon, Watertown, CT;
2. Signamax, Miami, FL;
3. Or approved equal.

D. Fiber Patch Panels (Wall Mount) shall be manufactured by:

1. Panduit, Tinley Park, IL;
2. Signamax, Miami, FL;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Termination Blocks:

1. Termination blocks shall have the following properties:

a. Termination blocks shall be designed to accept Ethernet cable pairs without having to pre-terminate an RJ-45 or RJ-11. Converts cable

pairs to RJ-45 or RJ11 male plug end without the need for special tooling.

b. Termination blocks shall be BIX-style, wall mounted with legs in increments of 250 and 300-pair per unit, including both the wiring block and connecting block for field termination.

c. Termination blocks shall meet Category 6A specifications as verified by an UL, at minimum and shall support termination of 22-24 AWG solid conductors.

d. Termination blocks shall contain color-coded tips on the base wiring block and well as on the connector blocks and shall incorporate back openings for cable feed-trough.

e. Furnish and install wall-mounted backboard channels and troughs.

f. Adapts Ethernet cable wire pairs to a RJ-45 interface and is available in both T568A and T568B configurations.

g. Compact, craft-friendly, low-profile design fits into applications where space is limited.

B. Category 6A Shielded Patch Panels:

1. Patch panels for field termination of Category 6A Unshielded, Foiled Twisted Pair (U/FTP) cable shall have the following properties:

a. 19-inch rack-mountable panel with a 16-gauge steel frame having a black powder-coat finish.

b. The patch panel shall include a built-in cable management bar made of steel with nickel plating.

c. The patch panel shall be 24, 48, or 72 port configurations.

d. Accommodate at least 24 ports for each Rack Unit (RU). For high density applications, accommodate 24 ports on .5 RU.

e. 8 pin modular, shielded keystone jacks with Insulation Displacement Connectors (IDCs) that:

1) Meet Category 6A performance standards

2) Support T568A and T568B wiring schedules

3) Accept 22 to 24 AWG Category 6A U/FTP cable

4) Snap in and out of the patch panel

5) Terminate Category 6A, U/FTP cable with a single conductor impact tool or a 4- pair impact tool.

f. Space on the front and rear of all jacks for labeling and identification

g. Circuit boards tested in both directions, as required by ANSI/TIA 568.

h. Provide color-coded icons or color-coded designation label strips for all patch panels that are in compliance with TIA 606 and that identify voice or data functionality as required

C. Fiber Optic Patch Panels (Rack Mount):

1. Fiber patch panels for field termination of Optical Single-mode 2 (OS2) fiber shall have the following properties:

a. 19-inch rack-mountable panel with 16-gauge metal enclosure having a black powder-coated finish that is corrosive resistant.

b. The patch panel shall have removable transparent front cover made of high-impact thermoplastic with a UL94V-0 fire-retardant rating.

c. The patch panel shall have an easy-glide, removable sliding tray for easy access to the splice trays. The sliding tray shall include fiber cable management spools for cable slack storage.

d. The patch panel shall come with pre-loaded adapter plates and any unused adapter plates slots shall be covered with a blank plate.

e. The adapter plates shall have a 36, 48, or 72 fiber configurations.

f. The pre-loaded adapter plates shall come with Lucent Connector (LC) type adapters for OS2 fiber. The LC adapters shall be the Ultra Physical Connector (UPC) type with zirconia ceramic split sleeves.

g. The patch panel shall come with pigtails with one end having factory installed connectors. The other end of the pigtail fibers shall be field terminated and spliced in a splice tray.

h. The splice tray subassembly shall have tie-down holes for cable management, and the necessary number of splice trays shall be provided based on the number of adapters used.

i. The patch panel shall be equipped with appropriate means for physically securing the cables in place (front and rear), and shall provide sufficient rings, saddles, and guides to ensure that all cables and strands can be dressed in a neat and workmanlike manner and to maintain the required minimum bend radii for all changes in direction.

j. Equipped with an integral bonding lug or stud for securing the fiber strength member

k. The patch panel shall have knockouts for multiple trunk cable entry with rubber grommets.

l. Front and rear access patch panels be fitted with manufacturer-supplied labels for each enclosure, cable, and all termination positions.

m. The patch panels shall have all required accessories.

D. Fiber Optic Patch Panel (Wall Mount):

1. Fiber patch panels for field termination of OS2 fiber shall have the following properties:

a. Wall mounted, 16-gauge steel case with high-impact, corrosive resistant black finish.

b. Hinged one (1) or two (2) front door(s) with locking option.

c. Capable of using two (2) or four (4) modular adapter plates as required for the number of fibers used.

d. The pre-loaded adapter plates shall come with Lucent Connector (LC) type adapters for OS2 fiber. The LC adapters shall be the Ultra Physical Connector (UPC) type with zirconia ceramic split sleeves.

e. The patch panel shall come with pigtails with one end having factory installed connectors. The other end of the pigtail fibers shall be field terminated and spliced in a splice tray.

f. The splice tray subassembly shall have tie-down holes for cable management, and the necessary number of splice trays shall be provided based on the number of adapters used.

g. Splice tray space shall be able to accommodate two (2) to four (4) trays on the attached mounting nuts

h. Top and bottom trunk cable entry points with rubber grommet seals.

i. Fiber management brackets to ensure safe tension and bend radius

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

B. Install nameplates for identification of all patch panels.

3.02 INSTALLATION

A. All install all rack mount patch panels in the equipment racks identified on the Contract Drawings.

B. Install patch panels square and plumb and shall be securely fasten in the rack with a minimum of four (4) rack screws located in the four corners of each panel.

C. Install horizontal cable support bars at the rear of all patch panels as indicated on the manufacturer's instructions.

D. Attach all accessories supplied with the panels as per the manufacturer's instructions.

3.03 FIELD TESTING / QUALITY CONTROL

A. Patch panels shall be tested in accordance with the industry standard. Permanent link tests shall perform for all new installations.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SECTION 27 13 23 – COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install a fully functional fiber optic cable system, including fiber testing, accessories and splicing.

B. The entire fiber optic system is considered to be one system and provided by a single source, hereafter to as the Supplier.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 – General Electrical Requirements

B. Section 26 05 27 – Grounding

C. Section 26 05 53 – Identification for Electrical Systems

D. Section 26 06 11 – Cable and Conduit Schedule

E. Section 27 11 19 – Communications Termination Blocks and Patch Panels

1.04 REFERENCES

A.	ANSI/TIA/ EIA 455	-	General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
B.	ANSI/TIA/EIA 526	-	Standard Test Procedure for Fiber Optic Systems
C.	ANSI/TIA/EIA 568.0	-	Generic Telecommunications Cabling for Customer Premises
D.	ANSI/TIA/EIA 568.1	-	Commercial Building Telecommunications Infrastructure Standard
E.	ANSI/TIA/EIA 568.3	-	Optical Fiber Cabling Components Standard
F.	ANSI/TIA/EIA 598	-	Optical Fiber Cable Color Coding
G.	ANSI/TIA/EIA 569	-	Telecommunications Pathways and Spaces
H.	ANSI/TIA/EIA 606	-	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
I.	ANSI/TIA/EIA 607	-	Commercial Building Grounding and Bonding Requirements for Telecommunications
J.	ICEA S-104-696	-	Standard for Indoor-Outdoor Optical Fiber Cable

1.05 DESCRIPTION

A. Fiber optic backbone cabling for 10Base-F through 10GBase-LR Ethernet applications.

B. Fiber optic backbone cable shall be used for the backbone link portion of the structured cabling system that interconnects several buildings.

1.06 QUALITY ASSURANCE

A. Provide fiber optic cable that is listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory unless products meeting the requirements of these

testing laboratories are not readily available or unless standards do not exist for the products.

1. Provide fiber optic cable that is listed and labeled or approved as stated above for the location they are to be installed in.
2. Provide fiber optic cable that is listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide fiber optic cable that has been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Provide test results upon request of the Engineer.

C. Manufacturer Qualifications: Firm specializing in manufacturing fiber optic cable with minimum five years documented experience in production of similar products and equipment.

D. Installer Qualifications: Firm specializing in installing fiber optic cable with minimum three years documented experience constructing systems of similar size and type.

E. Install work under supervision of skilled and experienced installers.

1. Submit current qualifications of all installation employees who will work on the job.
2. Submit current qualifications of all supervisory personnel who will work on the job. Qualifications will consist of:
    a. Summary history of employee showing projects recently completed.
    b. Copy of current employee certifications.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers with the products they produce proposed for the contract.
2. Manufacturer's catalog cuts and drawings showing all technical information, and construction details for the fiber optic cable.
    a. Manufacturer and type of optical fiber.
    b. Material, number, and size of strands composing each fiber optic cable.
    c. Cable insulation thickness in inches with material and voltage rating.
    d. Jacket thickness in inches.
    e. Average outside diameter of bare fiber.

f. Average outside diameter of finished cable and jacket material.

g. Weight per 1,000 ft. of finished wire or cable.

h. Minimum bending radius, in inches.

i. Minimum pulling temperatures at which cable may be pulled without damage.

j. Maximum pulling tensions which may be applied to the cable without damage.

k. Literature identifying the methods and materials which Contractor proposes to use to make splices and terminations. Submittal shall consist of manufacturer's literature evidencing compatibility of the conductor insulation and jacket of the wire or cable with the splicing or terminating materials and methods which Contractor proposes to use.

l. Manufacturer recommended pulling lubricants.

m. Qualifications of splicing and termination personnel.

3. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least forty-five (45) days in advance prior to conformation of witness testing dates and actual testing.

B. Reports:

1. Shop and field test reports shall be submitted.

2. Acceptance testing report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Fiber optic cable shall be delivered, stored and handled in accordance with this Section, the Specifications and the manufacturer’s instructions.

B. The Contractor shall, inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance with this Section and the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fiber optic cable shall be as manufactured by:

1. Corning Cable Systems, Hickory, NC;
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Fiber Optic Cables:

1. Fiber optic cable shall meet the following summary specifications:
   a. Fiber type: Optical Single-mode 2 (OS2)
   b. Core Diameter: 9 microns
   c. Cladding Diameter: 125 microns
   d. Maximum Cable Outside Diameter: 10.5-mm (0.41-inch)
   e. Maximum Cable Weight: 62.5.6 kg/km (42.6 lbs/1000ft)
   f. Maximum Attenuation: .4 dB/km at 1310 nm and at 1550nm
   g. Bandwidth: N/A
   h. Buffer Type: Loose tube
   i. Number of Fibers: See Contract Drawings, which indicate fiber strand quantities and cables.
   j. Cable Central Strength Member: Dielectric
   k. Outer Jacket: Polyethylene (PE)
   l. Maximum Pulling Load: 600 lbf (2700N)
   m. Operating Temperature Range: -40 degrees C to +70 degrees C
   n. Parallel Plate Crush Resistance: 400 lbf
   o. Rated for use in ductbank apllications
   p. Quantity: As shown on Contract Drawings
   q. Packaging: Spools/reels, protected from shipment
2. Fibers within the cable shall be color-coded so that each fiber may be individually identified. The color sequence suggested is as follows: blue, orange, green, brown, slate, white, red, black, yellow, violet, rose, and aqua.

Dashed versions of the same colors may be used to continue the sequence, depending on the cable structure and fiber count.

3. The outer jackets of the cable shall be continuous, free from holes, splits, blisters or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as for fiber coatings.

4. Materials used for fiber optic cable shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards or applicable federal or state laws or regulations.

5. The color of the polyethylene outer jacket material shall be black in accordance with ASTM D 1248 and contain a suitable antioxidant substance. The carbon black used shall be furnace-type conforming to designation N 110 in accordance with the requirements of ASTM D 1765. The carbon black content in the jacket material when measured in accordance with the requirements of ASTM D 1603 shall be 2.6 percent ±0.25 percent by weight. The light absorption coefficient of the jacket material shall be at least 400 when measured at a wavelength of 375 nm in accordance with the requirements of ASTM D 3349.

6. Outer polyethylene jacket materials shall meet tensile strength and elongation minimum requirements for unaged and aged samples as follows:

   a. Tensile Strength at Break: 2800 psi (Unaged), 2100 psi (Aged).

   b. Elongation at Rupture: 400 percent (Unaged), 375 percent (Aged).

7. The cable jacket shrinkage test measures the shrinkage or expansion of a cable jacket exposed to temperature aging for a specified period of time. Maximum shrinkage shall be less than five percent for each specimen tested. The test procedure is described in EIA-RS-455, FOTP-86.

8. The cable shall be permanently marked to identify the manufacturer, date of manufacture, length markings, a product identification code, and UL messages, where appropriate. The markings shall be printed at regular intervals of not more than two feet apart.

9. The cable shall be packaged on a reel with inner hub diameter greater than the recommended minimum bending diameter of the cable. The anchor holes on the reels shall admit a 2-1/2-inch diameter spindle without binding. The package shall be sturdy enough to endure reasonable handling in the process of shipping and storage. The package shall bear the name of the manufacturer, the product identification code and the total amount of product on the reel.

10. The following information shall be securely attached to the reel as a tag or clearly and permanently stenciled or labeled on each reel:

a. Customer Order Number
b. Customer Job Number
c. Customer Reel Number
d. Termination
e. Ship Date
f. Manufacturer's Name
g. Factory Reel Number
h. Manufacturer's Cable Code (Type and Fiber count)
i. Length of Cable
j. Weight of Cable and Reel
k. Defect Tag

11. The ends of all cable shall be sealed to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage and installation.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Testing shall consist of making an OTDR trace of each fiber of each reel, at both 1310 nm and 1550 nm. The test shall incorporate a one km long backscatter suppression cable inserted between the OTDR and the fiber end. Each trace shall include the optical length and average attenuation.

B. The results of the testing shall be submitted to the Engineer prior to installation. Any cable that shows "out-of-spec" performance shall be replaced, at no additional cost to the City or delay to the Project Schedule.

3.02 INSTALLATION

A. All fiber optic cable shall be installed, terminated, and tested by the fiber Subcontractor specified above.

B. In pulling the cable, strain-relief, or other tension limiting devices shall be used to limit the pull tension to less than 600 pounds. The Resident Engineer shall witness the cable being pulled.

C. Minimum bend radius restrictions shall be satisfied both during and after cable installation.

D. All conduit and cabinet entrances shall be sealed with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.

E. Splices in the fiber optic cable shall only be made at termination points where connectorized pigtails are applied. Non-terminating field splices shall not be made. If a field splice is required, it shall be fusion spliced and placed in a buried pull box. Closures shall be AT&T UCB1 with Type 2000 outer case, SIECOR SC5, or equal. Encapsulant shall be placed between inner and outer closures. Such splices shall meet the loss parameters/testing requirements specified elsewhere.

F. Fiber optic trunk cables, installed between the fiber patch panels, shall not have cable to cable splices except for pigtail splicing at the end of the cable for termination in the fiber patch panels.

G. Fiber optic branch cables shall not have cable to cable splices except for pigtail splicing at the end of the cable for termination in the fiber patch panels, Process Monitoring and Control System control panels, or security interface panels.

H. If the cable becomes damaged during installation, Contractor shall stop their operations and notify the Resident Engineer, in writing, immediately. The City shall decide whether to replace the entire reel of cable or to install a splice at the damaged section.

I. If the City decides to replace the entire reel of cable, Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the City. Installation of new cable to replace damaged cable shall not be a basis of extra payment or Contract completion time. In addition to installation of the new cable, Contractor shall reimburse the City and entire cost of the replacement reel of cable. This cost will be withheld from the Contract price.

J. If the City decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at Contractor's expense.

3.03 FIELD TESTING / QUALITY CONTROL

A. Acceptance testing of the data highway (fiber and electronic equipment) shall be conducted as a part of integrated system field-testing, as specified elsewhere. Prior to such tests, however, the fiber optic cable shall be tested as specified herein.

B. The fiber optic Subcontractor shall conduct fiber optic cable testing as specified below. All tests shall be witnessed by Engineer and the City. A test plan shall be submitted at least one week prior to the proposed test date(s). The test plan and procedures shall be mutually agreed upon prior to conducting the tests.

C. Each optical fiber in every span shall be tested after installation and termination. For each fiber, an OTDR trace hardcopy is required. This end-to-end trace shall be performed from both ends of the fiber. The traces shall be made at 1310 nm and 1550 nm. Also, for each fiber, and end-to-end power attenuation (insertion loss) test shall be performed from both ends of the fiber. The attenuation test shall use a stabilized optical source and an optical power meter calibrated to the appropriate operating wavelength (1310 nm and 15500 nm).

D. For each installed fiber, the power attenuation shall not exceed the following, tested from connector to connector at the respective patch panels, at 1310 nm and 1550 nm.

$$(0.0004)L + (0.35)N + 3.0 \text{ dB}$$

where L = the length of the fiber in meters, and
N = the number of fusion splices in the fiber.

E. Any fiber optic cables containing one or more fibers not meeting this performance shall not be accepted by the City and shall be repaired or replaced at no additional cost to the City.

F. All fiber optic testing shall be documented on pre-approved test forms. Three copies of all documents (including OTDR traces) shall be submitted to the Resident Engineer upon successful completion of the testing.

G. Work at the termination cabinets shall be performed such that the fiber optic cables, and the fibers, are not subjected to undesirable bending both during the Work and when permanently fixed in place. The cables, fibers, pigtails, etc. shall be organized in a neat and orderly fashion within the enclosure. Inspection of the Work shall be performed by the Resident Engineer. Unsatisfactory work shall be reworked.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 27 15 13 – COMMUNICATIONS COPPER HORIZONTAL CABLING
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, material, equipment, and incidentals as shown, specified, and required to furnish and install a fully functional copper horizontal cabling system.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements

B. Section 26 05 27 - Grounding

C. Section 26 05 53 - Identification for Electrical Systems

D. Section 27 05 26 - Grounding and Bonding for Communication Systems

E.	Section 27 11 19	-	Communications Termination Blocks and Patch Panels

1.04 REFERENCES

A.	NFPA 70	-	National Electrical Code
B.	ANSI/TIA/EIA 568.0	-	Generic Telecommunications Cabling for Customer Premises
C.	ANSI/TIA/EIA 568.1	-	Commercial Building Telecommunications Infrastructure Standard
D.	ANSI/TIA/EIA 568.2	-	Balanced Twisted-Pair Telecommunications Cabling and Components Standard
E.	ANSI/TIA/EIA 569	-	Telecommunications Pathways and Spaces.
F.	ANSI/TIA/EIA 606	-	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
G.	ANSI/NECA/ BICSI 568	-	American National Standards Institute/National Electrical Contractors Association/Building Industry Consulting Services International, Standard for Installing Telecommunications Systems
H.	BICSI TDMM	-	Building Industry Consulting Services International, Telecommunications Distribution Methods Manual
I.	ANSI/TIA-1152	-	Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling
J.	IEEE Std 802.3	-	10Base-T; 100Base-T; 1000Base-T; 10GBase-T
K.	IEEE Std 802.3 af at/bt	-	Power Over Ethernet; Power Over Enhancements; Third Generation Power Over Ethernet

1.05 DESCRIPTION

A. Copper horizontal cabling for 10Base-T through 10GBase-T Ethernet applications.

B. Copper horizontal cable shall be used for the horizontal link portion of the structured cabling system that extends from the jack termination of the cable faceplate to its patch panel jack termination.

1.06 QUALITY ASSURANCE

A. General

1. All copper horizontal cabling and accessories shall be made by an approved manufacturer, and in their construction shall be employed the most improved commercial materials and process of manufacture.

2. Only copper horizontal cables and accessories manufactured under high standards of production and meeting the approval of the Engineer shall be used.

3. All copper horizontal cabling and accessories shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, ANSI/TIA/EIA, and the NEC.

4. NEC Compliance: Comply with NEC Chapter 8- Communications Systems. With special emphasis on Article 800.

5. UL Compliance: Provide products that are UL-classified and labeled.

6. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to Communications Systems".

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers shall be submitted with the products they produce proposed for the contract.

2. Manufacturer's literature, specifications and engineering data for copper horizontal cabling and accessories including but not limited to:

a. Manufacturer and type of wire or cable

b. Material, number, and size of strands composing each conductor.

c. Conductor insulation thickness in inches with material and voltage rating.

d. Jacket thickness in inches.

e. Average outside diameter of bare conductor.

f. Average outside diameter of finished wire or cable and jacket material.

g. Weight per 1,000 ft. of finished wire or cable.

h. Minimum bending radius, in inches.

i. Minimum pulling temperatures at which cable may be pulled without damage.

j. Maximum pulling tensions which may be applied to the cable without damage.

k. Literature identifying the methods and materials which Contractor proposes to use to make terminations. Submittal shall consist of manufacturer's literature evidencing compatibility of the conductor

insulation and jacket of the wire or cable with the terminating materials and methods which Contractor proposes to use.

l. Manufacturer recommended pulling lubricants.

m. Qualifications of termination personnel.

3. Description of shop and field-testing methods, procedures and apparatus with calibration dates shall be submitted. Testing methods and procedures shall be submitted at least forty-five (45) days in advance prior to conformation of witness testing dates and actual testing.

B. Reports:

1. Shop and field test reports shall be submitted.

2. Acceptance testing report shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Copper horizontal cabling shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish all spare parts, special tools and supplies in conformance with this Section and the Specifications.

B. The spare parts shall be listed in an index and packed in containers suitable for long term storage, bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copper Horizontal Cable shall be:

1. Superior Essex, Atlanta, GA;
2. Or approved equal.

B. Telecommunications Outlet/Connectors shall be as manufactured by:

1. Ortronics, West Hartford, CT;
2. Or approved equal.

C. Modular Jacks shall be as manufactured by:

1. Ortronics, West Hartford, CT;

2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Copper Horizontal Cable:

1. Copper horizontal cable shall be Augmented Category 6 (6A), unshielded, foiled twisted pair (U/FTP) type.
2. The U/FTP cable shall be constructed of four (4) balanced, FTPs with each pair made of 23-AWG insulated solid copper conductors.
3. Each twisted pair cable shall incorporate an overall shield made of aluminum polyester tape.
4. The U/FTP cable shall have a tin-coated drain wire.The U/FTP cable outer jacket shall be polyvinyl chloride (PVC) and rated as required to meet flammability requirements for cable installation location. Cables that are installed in an air handling space and not installed in a totally enclosed pathway system shall be UL plenum rated. Cable outside diameter for any 4-pair U/FTP cable shall not exceed 0.32 in.
5. The operating temperature range for the cable shall be -20 degrees to +60 degrees C.
6. The cable shall have a maximum pulling force that is not less than 100N.
7. The cable shall have a minimum bend radius of 8 x outside diameter.
8. The U/FTP cable shall have a characteristic impedance of 100 +/- 15 ohms.

B. Telecommunications Outlet/Connectors

Standard faceplate: accommodates (2) inserts. Attaches to standard NEMA single-gang or double-gang flush-mount junction box or plaster reducing ring.

1. Single jack/wall telephone faceplate with stand-off studs to accommodate wall phone. Attaches to standard single gang flush-mounted outlet box.
2. Two port surface mount box. Accommodates (2) inserts. Plastic. Provide blank for unused port.
3. Outlet frame for surface-mounted raceway. Fits in GFCI opening. Accommodates (3) inserts.

C. Modular Jacks

1. Jacks shall be designed for 100-Ohm, U/FTP cable termination.
2. Jacks shall meet or exceed the transmission requirements of TIA Category 6A.
3. Jacks shall be manufactured by an ISO 9001 registered manufacturer.
4. Each jack shall be an individually constructed unit and shall snap-mount in an industry standard keystone opening.
5. Jack housings shall be high impact 94 V0 rated thermoplastic.
6. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
    a. Contact Plating shall be a minimum of 50-micro-inches of gold in the contact area over 50-micro-inches of nickel.
7. Jacks shall terminate 22-26 AWG stranded or solid conductors.

8. The interface between jack and station cable shall be insulation displacement type contact.
    a. Cable pairs shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
    b. Jacks shall be compatible with standard single conductor impact termination tools.
    c. Jacks shall be supplied with wire retention caps.
9. Jacks shall have an attached color-coded wiring instruction label as an aid to the installer.
10. Jacks shall be available in a variety of colors for identification or designation of applications at the workstation or closet.
11. Default Jack color shall be white.
12. Jacks shall be compatible with TIA/EIA-606-B color code labeling and accept snap on icons for identification or designation of applications.
13. Jacks shall be supplied with installed dust covers to protect the jack opening and internal elements during installation until the jack is in use. No damage to the Jack pinning shall result from insertion or removal of these covers.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Horizontal cabling shall be factory tested according to TIA/EIA-568.2

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare and submit test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Visually inspect the horizontal cabling jacket material for NRTL certification marking. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA.

B. Visually confirm the required Category-rated marking of cables, outlets, cover plates, outlets/connectors, patch panels and other termination hardware.

C. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords and labeling of components.

3.02 INSTALLATION

A. Installation shall be in accordance with the equipment manufacturer’s instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

B. Coordinate and verify to ensure that horizontal cables shall not exceed the maximum standards-based distance limitations (295 feet) for horizontal cabling.

C. The maximum allowable total channel distance is 328 feet between equipment in the communications room and station equipment, including patch cables and station attachment cables.

D. Terminate every conductor, no cable shall contain unterminated elements unless otherwise indicated. Make terminations only at indicated outlets, terminals, cross-connects and patch panels.

E. Coordinate the installation of the horizontal cabling with the other work of this project. The Contractor shall ensure that construction and preparation of the rooms and spaces in which the work of this Section are to be installed are sufficiently complete before beginning work.

3.03 FIELD TESTING / QUALITY CONTROL

A. After installation, all horizontal cabling shall be field tested. Fielding testing shall include permanent link testing of the horizontal cabling. The field tests shall be performed by the Contractor who shall furnish all testing equipment. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide a report identifying the tests performed and the results obtained for each cable tested.

B. Test each Category 6A cable and accessories. Carry out the following tests on every pair of every Category 6A cable.

1. Conductor Continuity
2. Conductor Separation
3. Conductor Polarity
4. Pair Mapping
5. Near End Crosstalk (NEXT), Attenuation to Crosstalk Radio – Far End (ACRF), Attenuation to Crosstalk Ratio – Near End (ACRN) and Attenuation
6. Power Sum NEXT, Power Sum ACRN and Power Sum ACRF
7. Structural Return Loss and Delay Skew
8. Cable Length
9. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568. Perform tests with a tester that complies with performance requirements in “Test Instruments (Normative)” Annex, complying with measurement accuracy specified in “Measurement Accuracy (Informative)” Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Remove and replace cabling where test results indicate they do not comply with specified requirements. Retest cabling and provide test documentation.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install Transceivers and all other appurtenant equipment.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements.

B. Section 26 05 27 - Grounding.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems.
E.	Section 26 05 53	-	Identification for Electrical Systems.
F.	Section 27 13 23	-	Communications Optical Fiber Backbone Cabling
G.	Section 27 21 29	-	Data Communications Switches and Hubs

1.04 REFERENCES

A.	IEEE 802.3z	-	Gigabit Ethernet
B.	NFPA 70	-	National Electrical Code
C.	SFP MSA	-	Small Form Factor Pluggable (SPF), Multi-Source Agreement (MSA)
D.	UL 60950-1	-	Standard on Information Technology Equipment Safety
E.	FLPPS	-	Federal Laser Product Performance Standard, United States Federal Food and Drug Administration
F.	SFP-8472	-	Specification for Diagnostic Monitoring Interface for Optical Transceivers

1.05 DESCRIPTION

A. Transceivers shall be for serial optical data communication applications for single mode optical fiber.

B. The transceivers shall be Cisco-compatible, operate at a nominal wavelength, and comply with MSA SFP.

C. Each transceiver shall consist of a transmitter optical subassembly, receiver optical subassembly and an electrical subassembly.

D. All subassemblies shall be housed in a metal package/enclosure.

1.06 QUALITY ASSURANCE

A. Communication Transceivers shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, ANSI/TIA, and the NEC.

B. In addition to the requirements for the approval of materials and manufacturers specified in Article 5 of the General Conditions, the following provisions shall pertain to the work under this Specification:

1. Manufacturer's Qualifications.
    a. The Contractor shall provide evidence to the Engineer that the manufacturer has a minimum of five (5) years' experience, within the last seven (7) years, in the design, manufacture, and supervision of installation of communication equipment of the types required under this Specification.
    b. The Contractor shall provide evidence to the Engineer that the proposed manufacturer is regularly engaged in manufacture of

communications equipment of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

C. UL Compliance: Provide products that are UL-classified and labeled.

D. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to Communications Systems".

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers shall be submitted with the products they produce proposed for the contract.

2. Manufacturer's literature, specifications and engineering data for data communications switches and accessories including but not limited to:

B. Operation and Maintenance Manuals.

C. Reports.

1. All Shop and Field Test Reports.
2. All Manufacturer's site visit and Acceptance Testing Reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Communications Transceivers shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Contractor shall furnish all spare parts, special tools, and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools, and supplies with the Communications equipment, neatly wrapped, or boxed, indexed, and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. SFP Transceivers shall be as manufactured by:
   1. Cisco, San Jose, CA
   2. Or approved equal.

B. SFP+ Transceivers shall be as manufactured by:
   1. Cisco, San Jose, CA
   2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. SFP Transceivers:

1. SFP optical transceivers shall have the following properties:
   a. Fiber Type: Single mode
   b. Fiber Interface: Duplex LC fiber connectors
   c. Ethernet Standard: 1000Base-LX with transmission distance of 10 km
   d. Data Transfer Rate: Minimum of 1.25. Gbps (bi-directional)
   e. Laser:
      1) Wavelength: 1310 nm
      2) Class 1 Laser safe
   f. Power Input: 3.3VDC
   g. Operating Temperature: 0 degrees to +70 degrees Celsius
   h. Low Electromagnetic Interference (EMI) design
   i. Digital Diagnostic Monitoring (DDM):
      1) Supply voltage
      2) Laser bus connections
      3) Temperature
      4) Laser output power
   j. Hot swappable with steel enclosure and bale clasp

B. SFP+ Transceivers:

1. SFP+ optical transceivers shall have the following properties:
   a. Fiber Type: Single mode
   b. Fiber Interface: Duplex LC fiber connectors

c. Ethernet Standard: 10GBase-LR with transmission distance of 10 km

d. Data Transfer Rate: Minimum of 10.025 Gbps (bi-directional)

e. Laser:

1) Wavelength: 1310 nm

2) Class 1 Laser safe

f. Power Input: 3.3VDC

g. Low Electromagnetic Interference (EMI) design

h. Digital Diagnostic Monitoring (DDM):

1) Supply voltage

2) Laser bus connections

3) Temperature

4) Laser output power

i. Hot swappable with steel enclosure and bale clasp

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation.

3.02 INSTALLATION

A. The transceivers shall be installed in the SFP/SFP+ ports of the Cisco Ethernet switch.

3.03 FIELD TESTING / QUALITY CONTROL

A. The transceiver shall be tested for Original Equipment Manufacturer (OEM) host compatibly.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SECTION 27 16 19 – COMMUNICATIONS PATCH CORDS, STATION CORDS, AND CROSS CONNECT WIRE
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install patch cords, station cords and all other appurtenant equipment.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements

B. Section 26 05 27 - Grounding

C. Section 26 05 29 - Hangers and Supports for Electrical Systems

D.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems
E.	Section 26 05 53	-	Identification for Electrical Systems
F.	Section 27 13 23	-	Communications Optical Fiber Backbone Cabling

1.04 REFERENCES

A.	NFPA 70	-	National Electrical Code
B.	UL 467-2013	-	Grounding and Bonding Equipment
C.	ANSI/NECA/ BICSI N1	-	American National Standards Institute/National Electrical Contractors Association/Building Industry Consulting Services International, Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
D.	ANSI/TIA-568.0	-	Generic Telecommunications Cabling for Customer Premises
E.	ANSI/TIA-568.2	-	Balanced Twisted-Pair Telecommunications Cabling and Components Standard
F.	ANSI/TIA-568.3	-	Optical Fiber Cabling Components Standard
G.	ANSI/TIA-569	-	Telecommunications Pathways and Spaces
H.	ANSI/TIA-598	-	Optical Fiber Cable Color Coding
I.	ANSI/TIA-604 10	-	FOCIS 10 Fiber Optic Connector Intermateability Standard
J.	ANSI/TIA-606	-	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
K.	UL 1863	-	Standard for Communications-Circuit Accessories.

1.05 DESCRIPTION

A. Not used

1.06 QUALITY ASSURANCE

A. Communications patch cords, station cords, and cross connect wire shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, NEMA, UL, ANSI/TIA, ANSI/EIA and the NEC.

B. Each patch cord shall be tested to ANSI/TIA-568-C.2 component requirement by the manufacturer. The manufacturer shall test 100% of the path cords. Each patch cord shall be shipped with quality controllable, which is referenced to actual test data verifying high performance.

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. A list of proposed manufacturers shall be submitted with the products they produce proposed for the contract.

2. Manufacturer's literature, specifications and engineering data for patch cords, station cords, cross connect wires and accessories including but not limited to:

a. Manufacturer and type of patch cord, station cords or cross connect wires.

b. Material, number and size of strands composing each conductor.

c. Conductor insulation thickness in inches with material rating.

d. Jacket thickness in inches.

e. Average outside diameter of bare conductor/fiber.

f. Average outside diameter of finished wire (or cable) or fiber and jacket material.

g. The length of the patch cords, station cords, or cross connect wires.

h. The connector type for the patch cords, station cords, or cross connect wires.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Patch cords, station cords, and cross connect cables shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. Inspect patch cord and cable protective coverings for evidence of damage during shipment.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copper patch and station cords shall be as manufactured by:

1. Leviton, Bothell; WA
2. Or approved equal.

B. Fiber optic patch cords shall be as manufactured by:

1. Signamax, Miami; FL
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Copper Patch and Station Cords:

1. Patch and station cords shall be Category 6A, unshielded, foiled twisted pair (U/FTP) type.
2. The U/FTP patch and station cord shall be constructed of four (4) balanced, FTPs with each pair made of 28-AWG insulated stranded copper conductors.
3. Each twisted pair cable shall incorporate as overall shield made of aluminum polyester tape.
4. The patch and station cords' outer jacket shall be polyvinyl chloride (PVC) and dual rated for CM and LSZH.
5. Patch and station cords shall have a standard 8-position RJ-45 shielded modular plug on both ends, and the plug boot shall have an integral anti-snag feature.
6. Patch and station cord's plug shall have 50 micro inches of gold plating, and the plug body shall be polycarbonate with a UL 94V-0 rating.
7. Cord outside diameter for any 4-pair U/FTP shall not be more than 0.240 in. (4.7 mm) nominal.
8. The operating temperature range for the cord shall be -20 degrees to +60 degrees C.
9. The cord shall have bend radius of .74 inches.
10. The cord shall have a characteristic impedance of 100 +/- 15 ohms.
11. Patch Cords shall be available in 1, 3, 5, 7, 9, 15 -foot lengths.
12. Lengths shall be specified as per field site conditions. Custom lengths shall also be available, but only factory manufactured patch cords are acceptable.
13. The cord color shall be "White", and available as a standard color from the manufacturer.

B. Fiber Optic Patch Cords:

1. Patch cords shall be the Optical Single-mode 1 (OS1) type with a 9 μm core diameter and a 125 μm cladding diameter.
2. Patch cords shall be of the tight buffered construction.

3. The patch cords' outer jacket shall be polyvinyl chloride (PVC) and rated for OFNR.
4. Patch cords shall be zip cord duplex with pullable strain relief boot and duplex clip.
5. The patch cords shall have Lucent Connectors (LC) on both ends.
6. The LC connectors shall have ceramic (zirconia) ferrules with an insertion loss of 0.2 dB typical, 0.3 dB max and a return loss of 55 dB. The ferrule polish shall be the Ultra Physical Contact (UPC) type.
7. Patch cord diameter shall not be more than 2 mm.
8. The operating temperature range for the patch cord shall be -20 degrees to +60 degrees C.
9. Patch cord shall have minimum bend radius of 1.2 inches.
10. Patch cord attenuation shall be .35/.20 dB/km at 1310/1550 nm respectively.
11. Patch cords shall be available in 1, 3, 5, 7, 9, 15, and 25-foot lengths. Lengths shall be specified as per field site conditions. Custom lengths shall also be available, but only factory manufactured patch cords are acceptable.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Copper patch and station cords are not to exceed 16 feet in length.

B. Quantities of system elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.02 INSTALLATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the structured cabling system is installed for correct and safe operation.

3.03 FIELD TESTING / QUALITY CONTROL

A. All copper and fiber optic patch cords shall include factory test results.

B. The Contractor shall perform field testing of the copper and fiber optic patch cables. Field testing shall include patch cord testing of all cords and channel testing.

C. The Contractor shall perform channel testing on 15% of the supplied copper patch cords.

D. The field tests shall by the Contractor who shall furnish all testing equipment. The field tests shall be witnessed by the Engineer and certified by the Contractor. The Contractor shall provide a report identifying the tests performed and the results obtained for each patch cord tested.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install Data Communications Switches and all other appurtenant equipment.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 26 05 11 - General Electrical Requirements

B. Section 26 05 27 - Grounding

C. Section 26 05 29 - Hangers and Supports for Electrical Systems

D.	Section 26 05 33	-	Raceways and Boxes for Electrical Systems
E.	Section 26 05 53	-	Identification for Electrical Systems
F.	Section 27 13 23	-	Communications Optical Fiber Backbone Cabling
G.	Section 27 16 16	-	Communications Media Converters, Adapters, and Transceivers

1.04 REFERENCES

A.	NFPA 70	-	National Electrical Code. With special emphasis on Article 770 and 800
B.	IEEE Std. 1100	-	(IEEE Emerald Book)
C.	IEEE Std. 802.1ae	-	Media Access Control Security
D.	IEEE Std. 802.1d	-	Spanning Tree Algorithm
E.	IEEE Std. 802.1p	-	Quality of Service (QoS), 8 level transmission priorities
F.	IEEE Std. 802.1s	-	Multiple Spanning Trees
G.	IEEE Std. 802.1Q	-	Virtual Local Area Network (VLAN) tagging
H.	IEEE Std. 802.1w	-	Rapid Spanning Tree Algorithm
I.	IEEE Std. 802.1x	-	Port Based Network Access Control
J.	IEEE Std. 802.3	-	10Base-T
K.	IEEE Std. 802.3u	-	100Base-TX, 100Base-FX
L.	IEEE Std. 802.3x	-	Flow Control on the Gigabit Uplink Ports
M.	IEEE Std. 802.3z	-	1000Base-LX
N.	IEEE Std. 802.3ab	-	1000Base-T
O.	IEEE Std. 802.3ad	-	Link Aggregation (LACP)
P.	IEEE Std. 802.3af	-	Power over Ethernet
Q.	IEEE Std. 8023an	-	10GBase-T
R.	IEEE Std. 802.3at	-	Power over Ethernet Plus
S.	IP Multicast	-	Filtering through Internet Group Management Protocol (IGMP) Snooping, IP Routing, Inter- VLAN IP routing for full Layer 3 routing between two or more VLANs. IP Unicast routing protocols including v6– Static, RIP, RIPng, OSPF, IGRP, EIGRP, PIM, BGP, PBR, HSRP, Supports 1000 multicast groups, VRF, DHCP Snooping
T.	ANSI/NECA/ BICS 568	-	American National Standards Institute/National Electrical Contractors Association/Building Industry Consulting Services International, Standard for Installing Telecommunications Systems

U. UL 60950-1 - Standard on Information Technology Equipment Safety

1.05 DESCRIPTION

A. The Data Communications Switches shall be Ethernet network switches that connect devices to the Local Area Network (LAN) and allows these devices to communicate over the network.

B. The Ethernet network switch shall manage the flow of data and send data only to devices designated to receive the data.

1.06 QUALITY ASSURANCE

A. Data Communications Switches shall be designed, built, and tested in accordance with the latest applicable editions of IEEE, UL, and ANSI/TIA.

B. In addition to the requirements for the approval of materials and manufacturers specified in Article 5 of the General Conditions, the following provisions shall pertain to the work under this Specification:

1. Manufacturer's Qualifications.
   a. The Contractor shall provide evidence to the Engineer that the manufacturer has a minimum of five (5) years' experience, within the last seven (7) years, in the design, manufacture, and supervision of installation of communication equipment of the types required under this Specification.
   b. The Contractor shall provide evidence to the Engineer that the proposed manufacturer is regularly engaged in manufacture of communications equipment of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

C. UL Compliance: Provide products that are UL-classified and labeled.

D. NFPA Compliance: Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance pertaining to Communications Systems".

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's literature, specifications and engineering data for data communications switches and accessories including but not limited to:

B. Reports.

1. All Shop and Field Test Reports.
2. All Manufacturer's site visit and Acceptance Testing Reports.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Data Communications Switches and Hubs shall be delivered, stored, protected, and handled in accordance with the manufacturer's instructions, this Section, and the Specifications.

B. The Contractor shall inspect, and report concealed damage to carrier within the specified time.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Contractor shall furnish all spare parts, special tools, and supplies in conformance this Section and the Specifications.

B. Deliver all spare parts, tools, and supplies with the Communications equipment, neatly wrapped, or boxed, indexed, and tagged with complete information for use and reordering.

C. Furnish all spare parts as recommended by the manufacturer.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Data Communications Switches shall be as manufactured by:

1. Arista, Santa Clara, CA;
2. Cisco, San Jose, CA;
3. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. One (1) Gigabit Ethernet Switch:

1. Minimum Functional Requirements for the Switch:

a. Power over Ethernet (PoE)

b. Switchable PoE on all ports

c. Switches without individual control of port PoE power shall not be accepted.

d. Port speed configuration:

1) Individually configurable per port

2) Detect and Auto-Negotiate

e. Duplex Mode:

1) Individually configurable per port

2) Detect and Auto-Negotiate

f. 5-slot system to support up to 5-line card modules as well as to support up to 2-supervisor modules

g. Layer 2 and layer 3 managed switching

h. Port Mirroring

i. MAC based port trunking

j. Multiple Configuration methods:

1) Web browser interface

2) Software application via direct Universal Serial Bus (USB) connection

3) Front panel RS-232 port

2. Switch Hardware Requirements:

a. Switch Card Modules:

1) Hot-swappable switch cards and rear accessible

2) Redundant configuration with failover from active to standby

3) Switch cards to provide up to 1.15 Tbps of switching, 160k MAC addresses, and 160k IPv4 hosts.

b. Supervisor Modules:

1) Each module shall have a quad core x86 Central Processing Unit (CPU), 16 GB of memory and an integrated 120 GB Solid State Drive (SSD).

2) Dual supervisor deployment/configuration

3) Each module shall include the following high-performance uplinks:

a) Fiber uplinks: Four (4) x 100/1000 SFP ports.

b) Number of SFP transceiver modules: Four (4) x 1 Gigabit Ethernet SFP and hot pluggable in the SFP uplink/port.

c) Fiber type: Optical Single (OS) mode

c. Line Card Modules:

1) Each module to provide 48 x 10/100/1000 RJ-45 PoE enabled ports

2) Minimum of two (2) line card modules and the empty slots shall have line card blanks.

3) PoE:

a) Power:

(1) Internal PoE power supply: 255 watts (total for all ports combined)

(2) IEEE 802.3at Type 2, Class 4

(3) Maximum power per port: 34.2 watts

(4) Supported by all ports up to the maximum power capability of the main PoE power supply.

b) PoE Parameters:

(1) Enable: Enable PoE power to select port.

(2) Enable on Boot: Enable PoE power to select port on switch boot.

(3) Allocated Power: a predetermined PoE power level in watts is allocated from the overall available PoE power supply total.

c) Control Processor Accessible PoE Parameters:

(1) PoE power: Enable/Disable

(2) PoE ports shall be capable of individual PoE power control via remote control processor.

(3) Switch shall provide status feedback.

(4) PoE state at switch boot up.

d) Control Processor Accessible PoE Status Feedback:

(1) Link Status: Good/Down

(2) Data Transmission: Full/Half Duplex

(3) Link Speed

(4) PoE device connected

(5) Port PoE power usage in milliwatts

(6) Port PoE power allocated in milliwatts

(7) Port PoE power class

3. Chassis Ground:

a. Number of locations: two (2) on the front panel and two (2) on the rear panel.

b. Connector Type:

1) Two M4 x .07 screws

4. USB:

a. Number of connectors: 1

b. Connector:

1) USB Type-B female

5. Front Panel Indicators:

a. The following LED indicators shall be provided on the supervisor module:

1) Supervisor status LED

2) Supervisor active status LED

3) Power Supply Unit (PSU) status LED

4) Line card status LED

5) Switch card status LED

6) Fan status LED

7) Uplink status LED

8) Management Ethernet Port Status LED

b. The following LED indicators shall be provided on the line card modules:

1) Line card module status LED

2) Port Status LED

3) Port PoE Status, one indicator for each port

c. The following LED indicators shall be provided on rear panel:

1) Fan module 1 status LED

2) Switch card module status LED

3) Switch card module active status LED

6. Power Requirements

a. Internal auto-sensing Power Supply Unit (PSU):

1) Voltage:

a) Minimum: 100 VAC

b) Maximum: 120 VAC

2) Minimum of 3 PSUs are required and configured to provide redundant power.

3) Connector type: C19 – NEMA L5-20, 20A/125V

7. Frequency:

a. Minimum: 50 Hertz

b. Maximum: 60 Hertz

8. Current:
    a. Maximum Current: 12 Amps
9. Enclosure:
    a. Dimensions:
        1) Height:
            a) 12 inches (305 mm)
        2) Width:
            a) 17.3 inches (439 mm) rack mounting ears removed
            b) 19.0 inches (843 mm) rack mounting ears attached
        3) Depth:
            a) 16.5 inches (441 mm)
10. Mounting
    a. Standard 19-inch rack mountable, 7 rack mount units high.
    b. Switch shall include mounting kit for four-post rack mount and be installed in the network rack as shown in the Contract Drawings.
    c. Rack mounting ears shall be removable for free standing applications.
11. Fan Modules
    a. Hot swappable and incorporated with the switch cards.
    b. N+1 redundancy.
12. Network Features:
    a. Fault tolerant for use in a ring topology. The switch shall be able to detect a blocked port and redirect data flow in the opposite direction within 30 ms.
    b. Full duplex on all ports.
    c. Auto negotiation and manual configurable speed
    d. IEEE 802.1w Rapid Spanning Tree Protocol
    e. IGMP snooping
    f. IGMP filtering
    g. Configuration password protected
    h. Configuration backup capability
    i. SNMP V3
    j. 802.1Q VLAN

k. Port-based VLAN

l. MAC filtering for blocking unauthorized access based on MAC address

13. Environmental:

a. Operating temperature: 0 degrees to 40 degrees Celsius

b. Storage temperature: -40 degrees to 70 degrees Celsius

14. Software:

a. Provide software license for each unit.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Installation shall be in accordance with the equipment manufacturer's instructions and with recognized industry practices to ensure that the system is installed for correct and safe operation

3.02 INSTALLATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. Final field tests shall be performed for all communication equipment provided under this Specification, as specified in Article 13 of the General Conditions and Section 01 75 10 – Preliminary and Final Field Tests.

B. Data Communication Switches shall follow the recommended manufacturer's industry standard tests.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SECURITY
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 13 34 23 - Fabricated Police Booth

B. Section 28 10 00 - Access Control and Alarm Monitoring

C. Section 28 20 00 - Video Surveillance System

D. Section 28 51 00 - Security Intercommunication System

E. Section 28 16 46 - Hostile Vehicle Control System

1.04 REFERENCES

1. Not Used

1.05 DESCRIPTION

A. The Contractor, referred to throughout as "Contractor" or "Security Contractor" shall be responsible for furnishing and installing the Electronic Security System (ESS) in accordance with the SE-Series drawings and the Division 28 Specifications.

B. The Contractor shall perform all Work, provide products, and systems integration required for the Project in order to ensure complete and fully operational systems and proper installation of equipment.

C. The Contractor shall be selected early in the overall construction process to allow for coordination with other trades prior to installation of all support infrastructure, such as electric and low voltage. The Contractor is required to participate in biweekly meetings, unless otherwise instructed by the Owner and/or Engineer. Upon start of the installation process of the security system and/or support infrastructure, the Contractor is responsible for attending the coordination/construction meetings required by the Construction Manager.

D. The Contractor shall provide and pay all labor, materials, and equipment, sales and gross receipts and other taxes. The Contractor shall secure and pay for plan check fees, permits, other fees, and licenses necessary for the execution of Work as applicable for the Project.

E. Give required notices; the Contractor will comply with codes, ordinances, regulations, and other legal requirements of public authorities, which bear on the performance of Work.

F. The Contractor shall provide an ESS, installed, programmed, configured, documented, and tested.

G. Final color selection of each device will be instructed by the Architect. The security vendor shall be responsible for providing color options to the owner and Project Architect for review and selection.

H. All electrical, safety and fire codes shall be followed. If national, state and/or city codes differ on the same point then the strictest definition and/or interpretation shall be followed.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. All submittals provided within this section shall require the review and approval of both the Security Engineer, and of the Owner prior to proceeding with any procurement or installation of security related equipment.

B. Materials and Equipment List: The Security Contractor shall submit for approval, in .pdf format, a complete list of all materials, equipment and accessories proposed for ESS Work in accordance with these Specifications and Contract Drawings. This list shall include manufacturers, complete catalog identification numbers and model or system designator, quantities, options, catalog "cuts", basic system architectural block diagrams, and CPU software operating features. The submittal shall be in sufficient detail whereby the Engineer can readily identify the equipment and materials proposed. No consideration will be given to partial lists or lists submitted from time to time. Approval of materials and equipment will be tentative to the submission of complete shop drawings. The Owner shall not be obligated in any manner for any materials, equipment or accessories which have not been accepted by the Engineer.

C. Shop Drawings: The shop drawing submittals shall include highly detailed, to-scale, instrument-drawn drawings describing the products (systems, equipment, devices and materials) and Security Contractor's services as to precise locations, mounting and installation methods, equipment/system schedules, riser diagrams, point-to-point interconnect diagrams, system interface schedules or diagrams, power requirement schedules (per room and per cabinet/rack), stand-by/emergency power schedule (per room and per cabinet/rack).

1. The Contractor shall assure that each trade has coordinated Work with other trades, prior to submittal. Shop drawings shall be issued after the coordination drawings are signed off by all other trades. Any conflicts that occur with other trades shall be brought to the attention of the Engineer / Client Representative prior to issuance of the shop drawings.

2. No portion of the Work shall commence nor shall any equipment be ordered until the submittals have been approved in writing by the Owner, Owner’s Representative, Engineer and/or Architect. All Work shall be in accordance with approved submittals. A detailed completion schedule shall be submitted with all submittals.

3. The Security Contractor's Drawings shall clearly illustrate all mounting locations and methods. While some drawing details may be "typical," the Security Contractor's Drawings shall illustrate the installation detail of each unique application.

D. Calculations: Before furnishing or installing the ESS, the following shall be provided to the Engineer for review and approval:

1. Video Storage Calculations: Storage calculations shall be provided based on total number of fixed and pan/tilt/zoom cameras utilizing the following minimum storage parameters, and accounting for 20% future growth in

device quantities. The Contractor is responsible for coordinating video surveillance devices added under separate Kensico Contracts to ensure that the Network Video Recorder storage calculations provided account for these devices.

a. Average Frame Rate: 15 fps

b. Resolution: Highest resolution per camera

c. Duration of Storage: 60 Days

d. Continuous Recording

2. Bandwidth Calculations: Bandwidth calculations shall be provided based on final system configuration and quantity of devices, to allow for final coordination with the network design required to support the ESS.

3. Network Port Summary: Based on termination points of ESS field device, provide a summary of total number of network ports required in support of the ESS. Summary is to be provided in table format.

4. The Contractor responsible for pulling cable(s) between the security device and the head-end equipment located in communication closets/rooms is to identify total cable length from end-to-end. This information is to be provided in table format prior to furnishing and installing the cable(s). In addition, the Contractor is responsible for providing voltage drop calculations based on the routes of the cables and information found in the cable length table.

E. Spare Parts and Components List: At the conclusion of the Security Contractor's Work, the Security Contractor shall submit to the Engineer, a complete list of manufacturers' recommended spare parts and components required in order to satisfactorily maintain and service the systems for a minimum of two years.

F. Operation, Maintenance, and Service Manuals: Prior to Final Acceptance, complete sets of operation, maintenance and service manuals shall be submitted for systems and equipment provided under this Contract. The manuals shall be compiled, assembled and indexed into a single Portable Document File (.pdf) with active links and bookmarks to the individual sections. The Operation, Maintenance, and Service Manuals shall include the following:

1. Complete operating instructions.

2. Complete maintenance instructions, wiring diagrams, troubleshooting instructions.

3. Complete parts lists for each major item of equipment and/or for each system.

4. Complete collection of manufacturers' product and catalog literature for equipment and systems installed under this Contract.

5. Manufacturers' warranties.

6. Manufacturers cut sheets, operational and troubleshooting guidelines, and recommended
7. Maintenance schedules.
8. Camera preset coordinates and programming settings.
9. Power reset sequence.
10. Equipment quantities with model and serial numbers which includes any accessories.
11. Order reorder forms for replacements.
12. NVR storage calculations based on resolution of installed cameras and frame rate.
13. Where practical, internal wiring diagrams and schematics.
14. Software User Documentation: Manual shall include operating instructions, programming instructions, technical documentation and maintenance procedures to permit making changes to system configuration.

G. Record Drawings ("As-Builts"): The Security Contractor shall provide, and keep up-to-date, a complete record set of drawings which shall be corrected, and shall show every change from the original Specifications and Contract Drawings through Final Acceptance. The record set of drawings shall be protected against soiling, tears, and similar damage and defacement. This set of prints shall be kept on the job Site and shall be used only as a record set. (This shall not be construed as authorization for the Security Contractor to make changes in the Work without proper approvals.) Upon completion of their Work and before final payment, the Security Contractor shall electronically transfer all information to a complete set of drawings and submit the complete record set to the Engineer for review. Upon acceptance, the record set shall be retained by the Owner, or by representative. The drawings shall be provided in .pdf and .dwg formats. As-built drawing(s) depicting the Work performed to include:

1. Complete Site layout showing locations of all system devices.
2. Functional system block diagrams, identifying communication protocols, wire type, and appropriate distances.
3. Device wiring and installation drawings.
4. System point to point
5. Details of connections to power sources, including power supplies and grounding.
6. LAN network diagram shall include the following:
    a. The connection to the DEP WAN
    b. Fiber model number, type, identify strands used for the security system

c. Network switches including model number/ports used/IP addresses

H. Formal Test Plan and Procedures: Sixty (60) calendar Days prior to acceptance testing and final inspection, the Security Contractor shall provide a formal test plan and test procedures for the Engineer's review and comment.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Fabricate Police Booth in largest possible pieces in factory to minimize any field Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. GENERAL

1. Prior to installation of security equipment, a dedicated technical security working meeting shall be required between the Security Contractor, Security Engineer, and Owner to discuss standard requirements and proper application.

2. All terminations are to be completed/supervised by a Security Contractor trained and authorized by the system manufacturer to ensure all systems are properly installed per the direction of the manufacturer.

3. All equipment shall be attached to walls and ceiling/floor assemblies and held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

4. Current Site conditions: the Contractor shall visit the Site and verify Site conditions are in agreement with the design package. The Contractor shall report all changes to the Site or conditions that will affect performance of the system to the owner, Architect and Engineer in a report. The Contractor shall take no corrective action without written permission from the owner, Architect and Engineer.

5. Device and alarm naming conventions shall be provided to the Contractor prior to the submission of shop drawings. Should the Contractor program device and alarm names prior to receiving this approval from the Security Engineer and/or owner, the Contractor is deemed aware that they will be responsible to re-program according to the owner's requirements at no additional costs.

6. Terminations of the access control and intrusion detection devices, such as card readers, door position switches, vibration sensors, etc., onto access control system input/output boards, control boards, etc. will be per Security Engineer’s instructions. The Security Engineer will provide a termination schedule prior to creation of the shop drawing submittal. The Security Contractor will be responsible for reviewing the termination schedule and providing feedback. Security Contractor can propose an alternatives to the termination schedule, but may not proceed with the changes until it has been reviewed and approved in writing by the Security Engineer.

7. Network addresses for the programming of the electronic security system will be provided by the owner and/or the Security Engineer.

B. FAMILIARIZATION TRAINING

1. The purpose is to familiarize operators, security management, and technicians with the basic operating components of all control room system. This training will provide operators with sufficient information to monitor the alarm system during system installation, before final system configuration and acceptance has been completed. It will also provide technicians with enough information to provide a basic level of system service during the construction period.

2. The course shall be taught at the Project Site for a period of five (5) consecutive training Days. Generally, the Contractor should plan for the course to begin approximately 15 Days before scheduled system cut-over. Project management and system installation progress will determine the

appropriate time for familiarization training, and the Contractor will submit the dates for familiarization training to the Owner, Architect and Engineer within 60 Days of proposed date of delivery.

3. The Contractor shall submit for approval the training schedule and course curriculum 30 Days prior to course delivery. Course curriculum information shall include written learning objectives for each block of instruction. A maximum of 15 students per day will attend this course.

4. The general outline for the course will contain, at a minimum, the subject areas listed below. In-depth training in these areas will be addressed in follow-up courses for operators, supervisors and maintenance technicians. Upon completion of the course, operators should be able to perform elementary monitoring operations with guidance and describe the general hardware and architecture of the system.

3.02 IMPLEMENTATION

A. CABLING

1. All Ethernet cabling shall be furnished and installed by others. Security Contractor is responsible for coordinating with the security Engineer, Project Architect, and cable installer for the final locations.

2. All security cabling, except for the Ethernet cabling, jumpers and interconnects within an enclosure, shall be furnished and installed by the electrical Contractor. The Security Contractor is responsible for coordinating with the security Engineer and the electrical Contractor the cable types, quantities and routes.

3. The Contractor shall verify the size of all conductors. If the equipment that the Contractor intends to furnish and install has any special requirements, the Contractor shall provide for these requirements as part of the base bid.

4. Wiring systems shall be consistently color coded and tagged, using nomenclature that is consistent with system drawings and database configuration. Coordination of exact wire coding and tagging is mandatory. Final color coding and tagging requirements shall be coordinated with the Security Engineer during the submittal process.

5. Minimum size of conductors shall be 18 AWG, unless otherwise indicated. Contractor shall modify standard equipment input/output wiring terminals to accept 18 AWG. Exceptions may be allowed for manufacturer provided leads and internal equipment wiring, if approved by the Security Engineer.

6. The electrical Contractor shall provide 110 VAC input power for power supplies and other system components. Security Contractor shall be responsible for all low voltage power requirements. All equipment shall be from dedicated circuit breakers connected to the owner’s ups and emergency power distribution system.

7. The Contractor shall not exceed the maximum tensile force that the manufacturer recommends when pulling cable.

8. All conductors must test free of opens, shorts and grounds by the installing Contractor before the termination of security devices by the Security Contractor.

9. When installing shielded cable, the metallic continuity must be maintained throughout the entire length of the cable run and the cable shield must be isolated from ground.

B. CABLE CONTAINMENT, SUPPORT INFRASTRUCTURE AND ENCLOSURES

1. All conduits, penetrations, junction boxes, cable ladders and required supports shall be provided by others. The Security Contractor is responsible for coordinating final security requirements associated with cable containment and routing.

2. Contractor shall verify the size of all conduits and junction boxes (40% maximum fill) with the electrical Contractor.

3. Raceways and conduits shall be concealed in wall and ceiling. Exposed raceways, where necessary and approved by the Security Engineer, shall be run parallel to or at right angles to walls. Any pathways shared between security and non-security low voltage cabling shall maintain physical separation between the two.

4. 110 VAC power conductors shall not be installed in the same conduit as low voltage security wiring.

5. All grounding and bonding shall be per the Electrical Engineer's requirements and be in accordance with all applicable codes.

6. Bend radius of conduits, pull box locations and pull box sizes shall be used as required by the Telecommunications Engineer and Electrical Engineer.

7. Conduit runs cannot contain the equivalent of two 90-degree turns in any dimensional plane without the addition of a pull box.

8. Bushings shall be installed at the end of all conduits to avoid chaffing of the cable.

9. All enclosures that contain splices and/or terminations of security wiring which utilizes a lid that require screw fasteners, shall utilize pin Torx 5 lob security screws. All other enclosures shall be keyed locked.

10. All enclosures that contain splices and/or terminations of security wiring shall be provided with a tamper switch that is activated whenever the cover is opened or removed.

C. FIRE

1. The access control system shall be interfaced with the fire alarm system to shunt power from the lock power supply to the electronically access controlled doors, as required by code.

2. Where cables and/or conduits pass through fire rated, fire resistant and/or fire stopped floors and walls use cable sleeves that prevent the spread of fire or products of combustion. Sleeves shall be nelson "flame seal" or as approved by the Security Engineer. Approved fire seals shall also be provided at all cable and conduit penetrations through fire rated walls and floors.

3.

3.03 FIELD TESTING / QUALITY CONTROL

A. The testing identified within this section is in addition to any system specific testing identified within the other Division 28 Specifications.

B. Preliminary test: following installation, the Security Contractor shall individually test each sensor and other components and verify the proper functioning of each component. The electronic security system shall be tested until all detection zones, alarm assessment components, alarm reporting and display, access control functions, video transmission, video storage and interfaces have been verified. Any deficiency pertaining to these requirements shall be corrected by the Security Contractor prior to final functional and operational tests of the system.

C. Operational test: following completion of the preliminary tests, the Security Contractor shall conduct a formal test, to be known as the "system operation test", in which all components and subsystems of the electronic security system are demonstrated to operate together as an integrated system. This test shall be performed over a continuous seventy-two (72) hour period.

D. Acceptance test: the acceptance test and final inspection will be accomplished in the company of the security Engineer and owner. Prior to the test date, the Security Contractor shall prepare and submit for approval of the Security Engineer, a complete and detailed Final Acceptance test check off list ("punch list"). The list shall be a complete representation of all specified functions and conditions, including contingency, priority, and abnormal modes of operation. The arrangement of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The tests shall be structured so that all sensors and controls are stimulated directly in their installed and finally adjusted positions and all audible and visual displays, signals, alarms and other responses are observed and printed. At the time of Final Acceptance testing, all required tests shall be repeated and all defects will be corrected until the system is found to be acceptable to the Security Engineer. A log of all test activities and results shall be maintained by the Security Contractor.

E. The Security Contractor shall carefully plan and coordinate the Final Acceptance tests so that all tests can be satisfactorily completed during one continuous testing period. The Security Contractor shall provide all necessary instruments, labor and

materials required for tests, and qualified technicians in sufficient numbers to perform the tests.

F. Although successful completion of the acceptance test has been completed, the security system shall not be considered accepted until it is determined that the complete security system is continuously trouble-free and operational, in a manner satisfactory to the owner, for a thirty (30) continuous Day period following Final Acceptance testing. A print-out of the system's activity log will be accepted as proof of compliance with this requirement. In the event that the system fails this operational test, the Security Contractor shall make the necessary adjustments and the thirty (30) Day period will restart from the beginning. If the system fails to complete this operational test for two (2) consecutive restarted test periods, the system shall be considered inoperable and unacceptable. The Security Contractor shall make all necessary repairs, adjustments, and/or replacements, at their cost. When all adjustments have been completed and after proper notice has been given, the complete acceptance test will be re-performed and witnessed from the beginning. The Security Contractor shall be liable for all expenses for witnessing the retest. Repeated unsatisfactory operation and chronic system failures shall be considered cause for the complete system removal and replacement by the owner. In this event, the Security Contractor shall be liable for all expenses and damages incurred.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. The Contractor will not be held responsible for failures in system performance resulting from the following:

1. An outage of the main power in excess of the capability of any backup power source provided the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the ESS performed as specified.

2. Failure of an Owner furnished equipment or communications link, provided the failure was not due to Contractor furnished equipment, installation, or software.

3. Failure of existing Owner owned equipment, provided the failure was not due to Contractor furnished equipment, installation, or software.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 08 71 01 – Finish Door Hardware

B. Section 13 34 23 - Fabricated Police Booth

C. Section 28 05 00 - Common Work Results for Electronic Security

D. Section 28 20 00 - Video Surveillance System

E. Section 28 51 00 - Security Intercommunication System

F. Section 28 16 46 - Hostile Vehicle Control System

1.04 REFERENCES

1. Not Used

1.05 DESCRIPTION

A. Description of Work

1. The Security Contractor shall provide and install the alarm monitoring/control, intrusion detection, and card access control system, which shall include all signage, audio/video communications devices, access control panels, I/O boards, card readers, access cards, request-to-exit devices, intrusion detection sensors, duress switches, and controller and lock power supplies.

2. The intent of the System is to provide access control for selected portals and monitor the status of selected portals, equipped or not equipped with access control, through the use of electronic equipment. The System shall also allow inputs from panic devices and intrusion detection devices.

3. The Security Contractor is responsible for providing all required software, installation of software, and system configuration and programming.

4. The access control and alarm monitoring system provided under this scope of Work shall integrate seamlessly with the current access control and alarm monitoring system deployed at existing DEP Sites. All devices installed within this scope of Work shall be capable of being monitored/controlled locally at the Temporary and Permanent Shaft 18 Booths and remotely over the DEP WAN.

5. The access control and alarm monitoring system shall interface with the video surveillance system to allow for camera call-ups during alarm conditions. In the event of an alarm, an associated fixed camera will be automatically called up within the Temporary and Permanent Police Booth Control Room workstation, in addition to any associated PTZ camera coverage being redirected to the alarm location.

6. Under vehicle carriage inspection cameras are to be provided at the Temporary Police Booth vehicle entry points for screening of vehicles through the use of high-resolution imaging. The system shall be capable of identifying unusual materials hidden on the undercarriage of a vehicle, and alerting an officer within the Temporary Police Booth of any findings.

B. System Description

1. The System outlined in this section is the key central component for managing physical security and the bridge between physical and logical security for this project. The system shall provide a variety of integral functions including the ability to regulate access and egress; provide identification credentials; monitor, track and interface alarms.

2. The System shall be interfaced to the fire alarm system for the automatic unlocking of door, as needed, as well as sharing door position status information, as required by code. The fire alarm system is to Work independently of any inputs from the Access Control System.

3. The access control system shall be equipped with dedicated battery backup in a remotely located system (i.e. remote access control enclosures) capable of supporting the operation of all equipment for a minimum of four continuous hours without recharge or replacement. All associated access control power supplies shall have the ability to remotely power cycle devices that are connected to it.

4. All enclosures housing access control head-end equipment shall be provided with a tamper switch and hasp to allow for locking via a mechanical padlock.

5. The card readers provided under this scope of Work shall be capable of reading the existing credentials currently distributed to DEP employees.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Not Used

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All devices are to be UL listed and approved for the use with which they are serving, unless otherwise noted or pre-approved by the security Engineer.

B. Final selection of color and finish of product is to be per instruction of the Project Architect.

C. Refer to Division 8 Specifications for information on electronic lock types and models.

1. Access Control Software

a. Lenel OnGuard

b. No other brand is acceptable

2. Access Control Panels
   a. Lenel LNL-3300 Intelligent System Controller
   b. Lenel LNL-1320 Dual Reader Interface Module
   c. Lenel LNL-1100 Input Control Module
   d. Lenel LNL-1200 Output Control Module
   e. Lenel LNL-1300e Network Door Interface Module/IO Module (for use in exterior enclosures)
   f. No substitutions accepted
3. Power Supplies
   a. Lenel LNL-AL400ULX
      1) Low battery and AC fail supervision alarms to be reported to the Lenel OnGuard system for monitoring by a DEP Police Officer with the appropriate credentials.
   b. Altronix TROVE Series
   c. LifeSafety Power MClass Series
   d. Or approved equal
4. Access Control Battery Backup
   a. Altronix ABT-12
   b. Or approved equal
5. Card Readers
   a. For wall mount applications:
      1) HID multiclass SE RP40 for access control
      2) HID multiclass SE RPK40 for arm/disarm interior reader
   b. Or approved equal
6. Door Position Switch
   a. Magnasphere HSS L2C with embedded end-of-line resistors
   b. Or approved equal
7. Access Control Cables
   a. Composite: Belden 538AFS (non-plenum) / 638AFS (plenum)
   b. 2 Conductor / 16 AWG: Belden 5200UE (non-plenum) / 6200UE (plenum)

c. 2 Conductor / 18 AWG: Belden 5300UE (non-plenum) / 6300UE (plenum)

d. 4 Conductor / 18 AWG: Belden 5302UE (non-plenum) / 6302UE (plenum)

e. Or approved equal

8. Photoelectric Beam

a. Optex AX-100PLUS

b. The Photoelectric Beam shall be installed to detect pedestrians approaching the entrance.

1) When the beams are intercepted the following shall be done:

a) Annunciate locally in Police Booth with light and audible alarm (light brightness and volume may be adjusted by DEP Police Officer). See Sounder/Strobe information below.

b) Activate additional motion sensor lighting where applicable. These motion activated lights should be installed to work in conjunction with the roadway lighting to provide adequate lighting for DEP Police Officers at night.

c) Status light will indicate to DEP Police Officer in booth whether there is power to the Photoelectric Beams.

2) Provide surge/lightning protection

c. Or approved equal

9. Sounder/Strobe

a. Dortronics 7201xL10HWRxCSW

b. Or approved equal

10. Intrusion Keypad

a. Lenel Command Keypad LNL-CK

1) LED indicators/Status displayed on screen:

a) System Armed (Green)

b) System Disarmed (Red)

c) Door Not Ready (Red)

d) Motion Detector Not Ready (Red)

11. Under Vehicle Carriage Inspection
    a. UVEye Helios
        1) The under vehicle carriage inspection shall be capable of taking high resolution imagery of the underside of a vehicle for comparison to a database of images. Any anomaly within the image shall generate an alarm in the Lenel OnGuard system.
        2) The sensor shall be IP54 rated, made with galvanized steel, and capable of scanning vehicles driving up to 15 miles-per-hour.
12. Electronic Lock/Request-to-Exit (for reference only)
    a. Electronic locking provided under Division 8 scope of Work. The information within this section is for reference only.
    b. Night latch: A key must be able to unlock/open the door both during normal operation and in the event of a power failure.
    c. Request to Exit: Turning the handle from inside the building must provide a request to exit signal to be processed by the Access Control System.
    d. Electric latch retraction: The latch must be able to be opened with an electrical signal from the Access Control System on a valid card read.
    e. Mfg. / Model No.: Von Duprin ELRX 99 NL, or approved equal

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. The Contractor who will be installing the Electronic Security System (ESS) must be a Lenel certified installer and integrator Lenel Value-Added Reseller (VAR).

B. The Contractor must provide documentation to prove experience in supplying, installing and integrating access control and intrusion detection systems.

C. The Contractor must confirm that the proposed design for this Project is achievable and verifies all Lenel and associated equipment necessary for design implementation.

D. The Contractor must furnish, install and program a system that is uniform, compatible and integrated with the NYCDEP's existing Lenel OnGuard security system.

E. The Contractor must perform on-Site and off-Site (NYC DEP Police Command Center) installations, programming, adjustments and data-entry to the ESS including associated computer equipment, communication transmission equipment, data transmission media, local processors, Intrusion detection sensors, access control devices, and support equipment that will be monitored at the Communication Center.

F. The Contractor must coordinate with the Engineer System Administrator to ensure that all programming complies with existing standards.

G. The system shall be installed by qualified technicians who have been factory trained and certified.

H. Wiring shall be uniform and in accordance with national electric codes and manufacturers instructions.

I. Equipment shall be firmly secured, plumb, and level.

J. All splices shall be in easily accessible junction boxes or on terminal boards.

K. All cable runs at the main terminal board and in all junction boxes shall be tagged and identified.

L. Coordinate all Work with other effected trades and Contractors.

3.02 IMPLEMENTATION

A. All AC power feeds to the system shall be installed in conduit separate from the data bus communication and low voltage control cables. The 120 VAC input power shall be furnished and installed by the Electrical Contractor. The Security Contractor shall be responsible for coordinating their requirements with the Electrical Contractor.

B. The Security Contractor shall furnish and install, in accordance with the manufacturer's instructions, all interconnect wiring, and equipment necessary for the erection of a complete system as described herein and shown on the drawings. All wiring termination, except 120 VAC power inputs and above door finish hardware device inputs, shall be the responsibility of the Security Contractor.

C. Access Control Doors Sequence of Operations

1. General:

a. The Access Control System under this Project shall be implemented in such a way that all electric locks on the doors can be controlled (locked and unlocked) from the NYCDEP Police Command Centers over the NYCDEP WAN.

2. Entrance Strategy (under Normal Operation):

a. All exterior doors and/or hatches shall always remain closed.

b. Entry doors to the Electrical Building shall have access control to the interior of the building. When a person presents DEP issued proximity card and pin, the card-holder is checked if he/she has the necessary credentials to enter. If the person is authorized to enter the building, a command is sent to release the electric door locks which opens and allows the person to enter the building. If the person does not have necessary credentials, the door lock will not unlock. Alarm notification shall be sent to the existing NYCDEP Lenel OnGuard server and will appear on the Lenel monitoring workstation at the Shaft 18 Temporary Police Booth (and the permanent Shaft 18 Police Booth).

c. When the person is authorized to enter, the electric lock will be unlocked and the person will enter the facility. The door contact will send an alarm when opening of the door or hatch and send a signal to the associated Lenel 1320 dual card reader module and then to the intelligent system controller board which will enable a timer. The person will be allowed to enter the building to arm/disarm the system at the interior card reader nearby and present DEP issued proximity card and pin within the preset time. A system status indicator (LNL-CK) shall be located next to the interior arm/disarm card reader to provide system status. If the DEP issued proximity card and pin is presented within that time, the card reader sends the card-holder's data to the Lenel access controller board where the card-holder is checked for correct credentials. If the person is authorized to enter the building, the system is disarmed. If a valid card with the necessary credentials is not presented within the entry delay time, the event will be logged in the existing Lenel Server at Eastview Precinct and the building will not be disarmed. Prior to exiting the building, the person will arm the system at the arm/disarm card reader. The system status indicator shall indicate the current status of the system. The screen will read “Door in alarm” when any door contacts are detected to be in an alarmed state (door open or wiring issue).

d. Intrusion Detection Strategy: All the access controlled doors, exit only doors and access hatches shall have door contact switches installed. The main purpose of the door contact switch is to signal any unauthorized intrusion (forced access from outside without an

authorized card-read) and send a signal to the Lenel Controller board and to the existing Lenel Server in Eastview Precinct. The event would be recorded and generate an alarm. A notification shall be sent to the Lenel OnGuard server at Eastview Precinct and the alarm will be monitored at the Lenel monitoring workstation at the Shaft 18 temporary booth.

e. Exit Strategy: Whenever a person tries to exit a door or a hatch, they will approach the door from the secured side. They then will "arm" the access control system by presenting their DEP issued proximity card/pin and arm code at the arm/disarm card reader. When the system is "armed" the access control system shall start an adjustable exit timer to enable the person to exit through the door and the electric locks will lock automatically through the crash bars. If the door or hatch is left open when attempting to "arm" the system, the system status indicator will identify that this door is not ready (in alarm) or if a person is inside the facility with motion sensors triggered the system status indicator will indicate "motion not ready". If the person attempting to arm does not exit within the adjustable delay time an alarm will be activated in the system. If the door/hatch is left open and this exit timer expires, an alarm shall be generated. Request to exit switches shall be installed in the interior crash bars/interior door handles on all doors (both access control doors and exit only doors). When a person pushes the crash bar, the request to exit switches are activated shunting the door contact alarm and the latch on the lock will retract mechanically directly and it requires no special knowledge to exit the building. The security systems must comply with the NFPA Life Safety Code and there shall be no special knowledge necessary to exit the access controlled doors when the crash bar is pressed.

f. Alarm Conditions and Integration of Access Control/Intrusion Detection System and CCTV System:

1) The following events, as defined in the Lenel System, shall trigger an alarm event:

a) Door Held Open

b) Door forced open at access controlled doors (when a key is used to retract the latch on the lock to open the access control doors).

c) Access granted/denied under duress

d) Access denied: reader locked

e) Access granted-no entry made

f) Invalid card

g) Inactive card

h) Invalid access level

i) invalid facility code

j) Invalid PIN number

k) card reader tampered

l) Alarm active

m) Tamper (security panel intrusion) o. communication loss

n) AC Power Fail

o) Low battery

p) Lenel system supervision alarms for inputs and outputs:

(1) Line Error, Grounded Loop, Short Line, Open Line.

q) When any of the above mentioned alarms occur, the CCTV cameras shall provide surveillance.

g. Access Control and Intrusion Detection System Communication Strategy:

1) The Lenel-X3300 Intelligent System Controllers communicate over the DEP WAN to the existing NYCDEP Lenel Server. The Contractor shall provide a network switch for the following equipment: all cameras, Network video recorder (will reside on the LAN and WAN), IP Keyboard-Video-Mouse switches, Uninterruptable power supplies network cards, Lenel 3300 controller boards and IP Power Strips. The Contractor shall provide all network cabling to the aforementioned equipment from the network switch that will reside on the DEP's LAN and WAN. All event logs shall be sent in real time whenever the communication links (network lines) are operational. In case of loss of communications between the Lenel 3300 Intelligent System Controller boards and existing NYCDEP Lenel Server, the alarm/events shall be stored on the Lenel 3300 and transferred when communication is resumed. The authentication of DEP issued proximity cards shall take place with the locally stored card-holder data on the Lenel 3300 boards. All programming and data entry on-Site and off-Site must be performed by the Contractor.

h. Power Loss Operation

a) In the event of power loss, the UPS shall provide a notification over an installed network interface card (NIC) to alert of the power loss. The access control power supply should be wired to the Lenel to controller by means of a hardwired relay output that AC power has been lost. The Lenel server should provide an alert indicating that the system is on battery power. The UPS is to run the Security Access Control and Intrusion Alarm System for a minimum of (2) hours on battery power in the event of an extended power outage.

b) While UPS power is available, the Lenel system should follow the normal sequence of operation.

c) In the event of a UPS failure or total power loss, the Lenel system shall provide notification to the Lenel server.

d) In the event of a UPS failure and transferring to bypass mode, the Lenel system shall provide notification to the Lenel server.

i. Communications Failure

a) If the system controller loses network communications with the Lenel server, the system shall establish communications using the backup dial-up modem.

b) If the system controller loses all communication with the Lenel server, the system shall operate in offline mode, authorizing to valid cards stored in the controller's local memory.

c) The Lenel server should provide an alert that it has lost communication with the system controller.

j. System Malfunction

a) In the event of a system malfunction, no access cards shall be granted authorized entry. Entry may only be gained by physically unlocking the door with a key.

3.03 FIELD TESTING / QUALITY CONTROL

A. Monitored Door (Door Position Switch Only)

1. Open door to the full 90-degrees and release. The door should close and secure under the action of the door closer.

2. Verify when the door is opened that the door breach is displayed on the access control workstation.
3. Confirm that the identified camera alarm call-up function is activated and displayed on the call-up monitor.
4. Re-secure the door, acknowledge the alarm. Ensure the alarm is cleared on the access control workstation.
5. Verify door name/number references on access control system is correct.

B. Access Controlled Door

1. Open door to the full 90-degrees and release. The door should close and secure under the action of the door closer.
2. Present invalid/unauthorized ID card to the reader. Ensure that access is not granted and an unauthorized card alarm is received on access control system.
3. Present valid ID card to the reader. Ensure access is granted through the secured portal.
4. From the secure side of the door, turn handle/depress panic hardware and ensure that the REX provides non-alarm egress for doors with just single sided card readers. For doors with card readers on both sides, repeat steps 3 and 4.
5. Hold the door open for xx seconds and verify door held open alarm noted on access control workstation. "xx" seconds to be confirmed based on the door location and security requirements.
6. Force door opened and verify door breach is noted within 2 seconds on the access control workstation. For electric lockset doors, a plastic card will be inserted between the lock and the strike plate so that the door can be closed, but not "locked" the door will then be pushed open to simulate the forced breach.
7. Confirm that the identified camera alarm call-up function is activated and displayed on the call-up monitor.
8. Re-secure the door, acknowledge the alarm. Ensure the alarm is cleared on the access control workstation.
9. For fail-secure doors, activate the fire alarm system and ensure that the electronic lockset provides immediate egress.
10. Verify door name/number references on access control system is correct.
11. Verify from the access control system that the door can be remotely released from the mapping interface.

C. Performance Verification Test (PVT)

1. Once installed and configured, the associated equipment completely powered, and the controls checkout and initial operation, the Contractor shall

perform a Performance Verification Test (PVT) to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. The Contractor must develop and submit a PVT test procedure for review and approval by the Engineer at least 30 Days prior to the start of the PVT. Any defects or problems found during the test shall be corrected by the Contractor and then re-tested to demonstrate proper operation.

D. Endurance Testing:

1. 60-Day endurance test: A 60-Day endurance test period will commence after the system is accepted. Any issues considered by DEP-SEU to be critical to the operation and maintenance of the system that are detected during the 60-Day test period must be corrected promptly (within a week) by the Contractor. A new 60-Day endurance test period will begin following any corrective actions taken by the Contractor. During the endurance test, all punch list items must be addressed and fixed. Once punch list items are corrected, a subsequent walkthrough must be provided to demonstrate items were corrected. Any sequence of operation changes needed due to issues found during testing must be provided.

3.04 STARTUP / DEMONSTRATION

A. System shall include all software necessary for system configuration.

B. System shall be turned on and adjustments made to meet requirements of Specifications and on-Site conditions.

C. System shall be programmed to function as specified.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

B. Provide all labor, materials, equipment, and services, and perform all operations required for the complete installation of all equipment, directly or indirectly stated, pertaining to this section. This is inclusive of any and all sub-systems and components.

C. The Work of this section shall include, but not limited to the following:

1. Operable and fixed vehicle barriers:
    I. Operable Wedge Barriers
    II. Fixed Concrete Barriers
    III. Movable Concrete Barriers
2. Hydraulic power units
3. Control units and required wiring for control of the operable vehicle barriers required by the operable vehicle barrier manufacturer

4. Operable vehicle barrier controller, inclusive of all parts and wiring required for intended operation of the barriers

D. The Contractor is responsible for reviewing this Specification in conjunction with the engineering and architectural drawings. The dimensional sizes of the barrier and their finish shall be per the engineering drawings. The Contractor shall notify the Engineer and Architect of any conflict between the dimensional sizes and/or finishes found within this Specification and the engineering drawings for clarification before preparation of shop drawings or fabrication.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 13 34 23 - Fabricated Police Booth

B. Section 28 10 00 - Access Control Alarm and Monitoring

C. Section 28 05 00 - Common Work Results for Electronic Security

D. Section 28 20 00 - Video Surveillance System

E. Section 28 51 00 - Security Intercommunication System

F. Section 13 34 23 – Fabricated Police Booth

1.04 REFERENCES

A. Abbreviations and Acronyms:

1. Not Used

B. Reference Standards:

1. Not Used

1.05 DESCRIPTION

A. Description of Work

1. Contractor is responsible for having the manufacturer of the product, or a manufacturer approved representative, on Site during the installation process to monitor the Work associated with their product. The manufacturer is to define in writing at what stage(s) of the installation process for each barrier type is the manufacturer, or the manufacturer's approved representative, required to be on Site to witness and inspect the installation in order to certify the product has been installed in accordance with the manufacturer's requirements to achieve the desired performance of the barrier as identified within this Specification. The Contractor is responsible for furnishing an official letter from the manufacturer stating

that the Work has been done in accordance with the manufacturer's Specifications, and that the installation allows the security rating of the product required to be achieved and is in accordance with the testing that the product has been subjected to in order to obtain such rating.

2. Provide and install an anti-ram barrier system as tested per DOS or ASTM criteria for vehicle crash rated barriers. Operable barriers shall be hydraulically operated. Quantities and ratings of each barrier groupings are per architectural and engineering drawings. If the product proposed has not been tested and certified to one of these standards or the installation condition varies from the tested condition, the manufacturer shall provide an engineering judgment by a Professional Engineer licensed in the State of New York who is qualified and experienced in the design of vehicle anti-ram perimeters indicating that the barrier will perform as required by the desired rating identified. The engineering judgment shall be signed and sealed by the Professional Engineer and shall be provided with all necessary information to substantiate the claim. The information shall include, but not limited to, calculations, analysis, and simulations.

3. Each operable barrier shall interface with the access control system to allow for independent control locally and monitoring both locally and from a central security system.

4. Provide all necessary controllers, safety sensors (e.g. induction loops, etc.) and other input sensors.

5. Coordinate the installation of the anti-ram barrier installation with the other trades to ensure proper operation of the barrier, as per manufacturer's requirements. This includes coordination with electrical, communications, plumbing, drainage, and security.

6. The barriers should be installed on a slight roadway crown perpendicular to the traffic to prevent water runoff from entering the barrier pit. The barrier pits must be sloped properly towards drains to prevent water accumulation.

7. Safety features shall be provided to avoid accidental deployment of the anti-ram barrier while a vehicle or person is within the path of travel of the barrier. In addition to a photoelectric beam to detect if a person or vehicle is within the travel path of a barrier, the Contractor shall provide a means of detecting a vehicle either over or within close proximity to the barrier through the use of device that utilizes a magnetic field. The detection of a vehicle shall be through the use of the ground loop detector.

B. System Description

1. The control point shall comprise two lanes, each operable for either inbound or outbound traffic, divided by a concrete barrier. Control point shall include the following at a minimum:

I. Buzzer with intercom to allow two-way communication between a vehicle operator and the police in the adjacent booth.

II. Integrated concrete barrier and chain link fence to constrict traffic to the control point and prevent vehicles from bypassing the vehicle barrier.

III. Push Button Manual Controls:

1. On/Off key switch
2. Open command
3. Close command
4. Stop Command
5. Emergency Fast Operation (EFO) with flip cover to disable all safety devices and close all barriers
6. Emergency operation reset

2. Each lane shall consist of the following, listed in order following the direction of travel for incoming vehicles:

I. Inspection bump.

II. Manually operable gate; a non-rated swing-arm vehicle barrier in front of and visible from the police booth.

III. Vehicle Induction Loop Sensor (in): Loops shall be programmed to operate bi-directionally as well as act as safety loops to prevent barriers from raising into a vehicle.

IV. Photoelectric Beam: Shall detect if a person or vehicle is in vicinity of the vehicle barrier.

V. Semaphore rising arm.

VI. Vehicle Arrest Device.

VII. Bi-directional Traffic light aligned Vehicle Arrest Device.

VIII. Semaphore rising arm (for reverse direction operation).

IX. Vehicle Induction Loop Sensor (out): Same performance as above

3. The operable barriers shall be M50 crash rated hydraulically driven rising-wedge barriers on inbound and outbound lanes for the main entrance as well as denial barriers. The clear span of each barrier shall cover a sufficient width of the respective lane so that vehicles cannot circumvent the measure.

4. All hydraulic lines and pistons shall be equipped with thermostat-controlled heat tracing that can be removed and replaced. The in-ground barrier pits are to be traced as well to prevent accumulated water from freezing. Heat trace should not be embedded in concrete.

5. Each barrier should have the following features installed:
   I. The operable wedge barriers shall have separate Hydraulic Power Units (HPUs)
   II. Provide hydraulic oil reservoir heater and HPU Cabinet ventilation and heater.
   III. All barrier electrified components must have a fused power disconnect mounted within HPU cabinet to provide for energy control procedures (Lock-out/Tag-out)
   IV. HPU cabinet must have a padlock hasp with protective shroud (no tumble lock).
6. Fixed and movable concrete barriers shall be not less than 2'-5" tall when measured from finished ground level and 2' wide at the base, placed on continuous foundations of 1.5' deep and 3' wide. Fixed barriers shall be anchored to prevent premature tipping or sliding similar to detailing in United Facilities Criteria UFC 4-022-02 Figure 6-15 and associated description.
7. Movable barriers shall be linked together with aircraft cable of minimum ¾" thickness to impede them from being moved without authorization.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Contractor to submit fully coordinated set of shop drawings showing all relevant details and trades prior to procurement of equipment and/or devices. Shaop drawings shall also be provided for HPU enclosures indicating proposed pedestal foundation detail.

B. Proposed color scheme and finishes shall be identified and submitted for approval and coordination with NYC DEP Bureau of Police and Security, Security Engineering Unit.

C. Details of biodegradable hydraulic fluid to be provided for approval.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All devices are to be UL listed and approved for the use with which they are serving, unless otherwise noted or pre-approved by the Security Engineer.

B. Final selection of color and finish of product is to be per coordination with NYC DEP Bureau of Police and Security, Security Engineering Unit.

C. Where a product type has been identified by manufacturer, the Contractor shall base their bid on that product.

D. Operable Wedge Barriers

1. Delta Scientific, HD300 Barrier

2. No other brand is acceptable. Sole sourced.

2.02 MATERIALS / EQUIPMENT

A. Operable Wedge Barriers

1. Performance Rating: M50

2. Barriers shall be a shallow frame below grade assembly that can be cast in a foundation of 24-inches in depth. The assembly shall have a heavy steel ramp weldment capable of being rotated to an above grade position.

3. In the fully deployed secured position the height of the barrier shall be 30-inches minimum as measured from the top of the foundation frame to the top of the barrier.

4. The width of the barrier measured across the face of the plate when fully deployed shall be per the architectural and engineering drawings.

5. Barrier shall be equipped with a debris screen that features high-contrast coloring to provide clear visibility that the barrier is deployed. Options for coloring of the barrier shall be presented to NYC DEP Bureau of Police and Security at the preparation of shop drawings. The debris screen should fully enclose the front face and sides of the barrier when deployed. The debris screen should readily removable to facilitate service and maintenance using standard hand tools.

6. Top surface of the barrier should have a non-skid roadway surface.

7. Wedge Barrier to be provided with all needed rubber pads, nylon blocks and other manufacturer recommended measures to minimize noise produced by Wedge Barrier when it is in operation and comes to a rest.

8. Wedge Barrier hydraulic fluid is to be biodegradable in order to reduce environmental impact from leaks and/or spillage. Details of the fluid provided are to be provided to NYC DEP for approval.

9. Speed of Operation:

I. Normal Operation: Each Barricade (or set) shall be capable of being raised or lowered in 3 to 6 seconds when operated at a repetition rate not greater than 120 cycles per hour. Barricade direction shall be instantly reversible at any point in its cycle from the control stations.

II. Emergency Fast Operation. Barricade shall rise to the secure position from fully down in 2 seconds maximum when the emergency fast operation button is pushed, provided the system has not previously been exhausted by power off, manual operation or high-speed cycle rates exceeding that of 120 cycles per hour.

10. Barricade shall operate satisfactorily under the following environmental conditions:

I. Maximum temperature of 110 °F

II. Minimum temperature of -10 °F

11. Power supply shall be provided to support sump pump.

B. Hydraulic Power Unit

1. Hydraulic power unit shall consist of an electrically driven hydraulic pump, electrical distribution, control circuits, valves, and manual hydraulic pumps and pressure release values.
2. The hydraulic power unit shall be contained within weather rated enclosure for protection against rain, snow and/or splashing from cleaning by maintenance of nominal dimensions 60-inches W x 36-inches D x 60-inches H.
3. The electric motor driving the hydraulic pump shall be fed from 460/3/60. Motor shall be sufficiently sized for the expected number of barriers within the group the HPU is associated with.
4. HPU enclosure to be equipped with:
   a. Exhaust fan(s) and associated vent(s) for cooling.
   b. Internal 120V/20A convenience receptacle for basic services and maintenance.
   c. Internal convenience light switched by the opening/closing of door.

C. Vehicle Barrier Controller

1. Master and Secondary Push Button Controller

I. SN 9030A-SP

II. B1086TL-S Slave Panel

III. B1036TL Master Panel

IV. Shall be a stainless steel enclosure, 18 Ga., with control pushbuttons mounted in sloped top for countertop mounting, all wiring assembled into a cable and inserted through a hole with a grommet. All exposed sheet metal joints welded and ground smooth.

V. Buttons associated with controller shall be recessed into a bezel ring to avoid accidental activation. The buttons shall illuminate to indicate the status of the barrier it is associated with.

VI. The Master Controller shall be equipped with key switches in order to individually lock-out each Secondary Controller separately.

VII. Each Secondary Controller shall be equipped with a key switch in order to allow local lock-out of the controller.

VIII. Controller shall allow for operation of barriers as described within the sequence of operations.

D. Traffic Light

1. Each set of operable barriers shall be equipped with a means of displaying a red and green traffic light that is visible to the vehicle operator during all times of the day and in all weather conditions. The intent of the light is to alert vehicle drivers of the vehicle arrestor position.

2. The green light shall indicate that the vehicle barrier is fully down and the driver may proceed with caution and the red light shall indicate that the vehicle arrestor is not fully down (either in the motion of lowering, in the motion of rising or fully up) and the driver should not proceed.

3. Lights shall be provided on both the secure and non-secure side of the barrier to signal a vehicle operator approaching from either direction.

4. Light system shall use a LED cluster. The cluster is to be made of equal amounts of red and green LEDs. The LED cluster is to be capable of illuminating the red and green LEDs independently of each other. The LED cluster must be able to continuously light the red LEDs and then switch to the green LEDs. The LED cluster shall require no more than 24 VDC, and have an intensity of no less than 5000 mCd. The light system must work within a temperature range of –20ºF to 110ºF.

5. The light system shall be integrated into a custom pylon adjacent to the operable barrier.

E. Safety Sensors

1. Vehicle Detector – Photoelectric Beam

I. Loop shall be made from #14 AWG machine tool wire, with a loop detector located on both the secure and non-secure side of an operable barrier.

2. Vehicle Detector - Loop Detector

I. Loop shall be made from #14 AWG machine tool wire, with a loop detector located on both the secure and non-secure side of an operable barrier.

II. Loop shall be cut into the roadway surface, install wiring and back-fill with appropriate caulk.

III. Modes of Loop Operation:

1. Constant signal on detection
2. Pulse on vehicle arrival
3. Pulse on vehicle departure
4. Pulse on arrival and departure

IV. Environmental Tuning: Unit shall be capable of following the environmental changes without tuning out a vehicle. Hold time is infinite on the detection of a vehicle. If a large metal mass were to affect the loop and create a detection, the next vehicle would correct the presence signal when it departs (i.e. self-correcting loop system).

V. Signal Delays: Unit shall be capable of having a delay programmed into the system to retard the time from detection to activation of an output.

VI. When a loop fault occurs, the unit shall provide a local visual alarm in the HPU and provide a output to signal a fault remotely at the push button controller location. Loop faults are triggered when the loop frequency falls below 20 kilohertz or rises above 75 kilohertz, indicating a loop open or short, respectively.

VII. Relay Signal Output: Processor to supply a 2 amp Form-C contact relay output in addition to a solid state switch signal output.

VIII. System to be provided with a loop isolation transformer allowing operation with loops grounded at a single point.

IX. Loop Inductance: 30-1,000 microhenries with Q factor of five or greater.

X. Operating Temperature: -40 F to + 180 F

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All operable barriers shall be visually inspected for conformance with architectural and engineering drawings and Specifications.

B. All operable barriers shall be visually inspected for any damages that may have occurred prior to delivery.

C. Verification of Conditions: Examine Site and verify that conditions are suitable to receive Work and that no defects or errors are present which would cause defective installation of products or cause latent defects in workmanship and function.

D. Notification of Unsuitable Conditions: Before proceeding with Work, notify the Construction Manager and Owner's Representative immediately of unsuitable conditions.

3.02 IMPLEMENTATION

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Conflicts between the manufacturer's instructions and the Specification shall be promptly brought to the attention of the Engineer by the Contractor prior to the initiation of any related Work.

B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

C. All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lock washers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for an anti-ram barrier set shall be capable of being locked in the power on and power off positions.

D. Wiring shall be routed as approved by the Engineer. All wires shall be installed in conduit unless otherwise noted. No splicing of wiring is permitted, except where necessary for connection at switches and sensors. Tag ends of all wires with a number code system, and record on as-builts.

E. Operable Vehicle Barriers

1. Foundation Work shall be coordinated with that of the adjacent fixed barrier foundation.

2. All controls shall be terminated with compression ring-style terminals. Roundhead screws and lock washers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis.

3. Install anchor bolts, shims, cutouts, slots, holes, recesses, fasteners or other attachment devices to securely anchor all equipment.

4. Level base plates to proper elevation using shims and neatly grout pack all voids using non-shrink non-metallic grout.

5. Position all equipment allowing sufficient access and clearance to permit maintenance, disassembly, repair and replacement.

F. Hydraulic Power Unit

1. Locate hydraulic power unit with recommended distance from operable barrier as specified by the barrier manufacturer. Assume all HPUs will be located approximately 50-feet or less from the barrier. Coordinate the final locations of the HPUs with the Engineer.

2. Coordinate with manufacturer for final size of hydraulic system components, such as system such as hose sizes, reservoir tank, accumulator, etc. to meet the needed operation of the barriers and the distance the HPU is located from the barrier.

G. Hydraulic Fluid Gauge

1. A hydraulic fluid level gauge shall be located at each hydraulic unit to indicate level of fluid. The gauge shall display the level of the fluid in the system. An LED shall flash on the exterior of the hydraulic power unit enclosure as well as at the Security Operation Center to indicate when the quantity of hydraulic fluid is at approximately 80% of the manufacturer's recommended amount and also to indicate which hydraulic power unit contains the low fluid level alarm. The LED is to be labeled "LOW HYDRAULIC FLUID LEVEL".

2. The status of the hydraulic fluid level must be connected to the Lenel System and show as a low hydraulic fluid level alarm.

H. Hydraulic Pressure Gauge

1. A pressure gauge shall be located at each hydraulic unit to indicate the pressure of each accumulator. The dial shall be divided into three different color zones, white, yellow and red. The white area is defined as normal pressure for operation of the wedge barrier . The yellow area is defined as low pressure, but still sufficient pressure to properly operate the wedge barrier . The red area is defined as pressure failure. When the pressure gauge is in the red area, the hydraulic power unit shall have 3 complete cycles before complete failure. An LED shall flash on the exterior of the hydraulic power unit enclosure as well as at the Security Operation Center to indicate when the low pressure of the accumulator and also to indicate which hydraulic power unit contains the low fluid level alarm. The LED is to be labeled "LOW HYDRAULIC PRESSURE".

2. The low hydraulic pressure alarm is to be connected to Lenel System and show as a low hydraulic pressure alarm.

I. Counters and Timers

1. A 6-digit counter shall be located at each controller circuit cabinet. This shall count the number of completed cycles of the wedge barrier system . A

complete cycle is constituted by one lowering and one rising of the wedge barrier .

2. A 6-digit timer shall be located at each controller circuit cabinet to time the hours and minutes the anti-ram barrier system motors are active. The timer shall count 00000 to 99999 hours and 0 to 9 tenths of an hour. The timer shall display "#####.# HR".

J. Heaters

1. For anti-ram barrier solutions whose operations are based on the use of hydraulics, the anti-ram barriers is to be equipped with hydraulic fluid heater, provided by same manufacturer, for the barrier. The heater shall be intended for use to maintain manufacturer recommended operating temperature of the hydraulic fluid within the reservoir. This includes the use of heat trace for use to maintain manufacturer recommended temperatures of the hydraulic fluid within the hydraulic lines.

2. Anti-ram barriers to be equipped with heat trace, provided by same manufacturer. The heat trace shall be intended for use to maintain manufacturer recommended temperatures of the barrier, specifically elements susceptible to malfunctioning or degrade in performance due to low temperatures.

K. Hydraulic Hoses

1. All hydraulic hoses shall be installed in a containment infrastructure (i.e. conduit) to allow for easy replacement of hydraulic hoses, as needed, at a later time.

2. All conduit shall be of materials that meet relevant code requirements and shall feature a sufficiently large radius at corners to prevent damage or difficulty when installing or replacing hydraulic lines. Conduits shall have smooth edges; sharp areas are to be eliminated or remediated to prevent damage to hoses.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Field Modifications

1. No field modifications to the crash rated barriers, including but not limited to cutting, drilling or grinding, shall be allowed without review and written approval of the Architect, Engineer, and manufacturer.

2. All field modifications must be evaluated and confirmed by the manufacturer that there will be no impact to the crash rated performance of the vehicle barrier or warranty.

B. Interface

1. The operable barriers are to be interfaced with the facility security system to allow for remote monitoring and logging of information for auditing. A Lenel contact shall be provided on each barrier to provide status of the barriers to the central security system. The EFO status shall also be monitored and reported to the central security system along with the ability to remotely reset the EFO status.

C. Contractor System Testing and Commissioning

1. The Contractor shall test all components of the anti-ram barrier system after installation and prior to interfacing with the access control system. Testing shall include, but not be limited to:

   I. Pressure test of all hydraulic hoses, valves and fittings;

   II. Testing of all wires installed for continuity, grounding, shorts and voltage drop;

   III. Operational testing of all hardwired button and switches, inclusive of safety devices;

   IV. Operational testing of all inputs and outputs of the controllers; and,

   V. Approved sequence of operations;

2. After interface with the access controls system, the Contractor shall conduct testing of the sequence of operations identified.

3. Sequence of Operation Verification

   I. Initial states

      1. Barrier: Raised (blocking traffic)

      2. Semaphore Gate arms: Lowered (indicating that vehicles may not advance)

      3. Traffic Light: Red (indicating that vehicles may not advance)

      4. Ground Loop: Nothing Detected

      5. Photoelectric Beam: Nothing Detected

      6. Lenel Contact: Indicates barrier is raised

   II. Normal Sequence of Operations

1. Vehicle approaches and stops in front of the semaphore barrier arm. Vehicle is detected by the photoelectric beam and the ground loop
2. Law Enforcement Officer (LEO) inspects credentials and authorizes vehicle to proceed.
3. LEO presses the "lower" button which triggers the following actions in sequence:
   a) Vehicle barrier lowers completely. Contact indicates that the barrier is lowered.
   b) Once vehicle barrier is completely lowered, the semaphore arms raises completely
   c) Once the semaphore arm is completely raised, the traffic signal light changes from red to green for that lane, in that direction of travel.
4. Vehicle passes over the barrier and beyond the subsequent semaphore arm. Vehicle is continuously detected by the ground loop and photoelectric beam
5. LEO presses the "raise" button which triggers the following actions in sequence:
   a) Traffic light turns from green to red
   b) Semaphore barrier arm lowers completely
   c) Once semaphore barrier is completely lowered, the vehicle barrier raises completely. Contact indicates that the barrier is raised.
6. All systems are now returned to the initial state.

III. Safety and Overrides

1. Detection by the ground loop or photoelectric beam of a vehicle or person in proximity of the vehicle barrier shall prevent the vehicle barrier from raising or the semaphore arm from lowering.
2. EFO shall override any safeties and immediately execute the commanded operation by the LEO
3. The vehicle barrier will not raise while either the photoelectric beam or the induction loop detects a vehicle or person in the vicinity of the barrier.

D. Finishes

1. All barriers, including all the bolts, fasteners, screws, washers, etc., to be protected from the effects of long-term corrosion. Corrosion resistant materials to be provided. Use hot dip galvanizing, for all exposed components, foundation structures and undersides.
2. Wedge Barriers: The roadway plates shall be painted in a black and yellow striping and have a non-skid surface. The Contractor to coordinate with the Architect and/or NYC DEP Bureau of Police and Security for selection of the final color that the surface is to be painted.
3. Appropriate lane markings shall be provided and coordinated with the installation of the barriers including a line indicating an appropriate stopping position in front of the barrier. Lane markings are to take into account the requirement for the direction of traffic to be fully reversible in each lane.

E. Waste Management

1. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 28 20 00 – VIDEO SURVEILLANCE SYSTEM
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 13 34 23 - Fabricated Police Booth

B. Section 28 05 00 - Common Work Results for Electronic Security

C. Section 28 10 00 - Access Control and Alarm Monitoring

D. Section 28 51 00 - Security Intercommunication System

E. Section 28 16 46 - Hostile Vehicle Control System

1.04 REFERENCES

A. Abbreviations and Acronyms:

1. Not Used

B. Reference Standards:

1. Not Used

1.05 DESCRIPTION

A. Description of Work

1. Provide a new Video Surveillance System (VSS) solution that includes, but is not limited to, IP-based cameras, signal converters, network video recorders, infrared illuminators, in-line surge protectors, and IP-based KVM and device mounting hardware (inclusive of recess mounts that are designed for use with camera).

2. The video surveillance system shall be integrated with the access control system and the perimeter intrusion detection system for automatic alarm call-ups and for tagging of video associated with an alarm condition.

3. The video surveillance system shall utilize video analytics. The Security Contractor is responsible for providing all necessary licenses and programming associated with the trip wire detection that is processed at the camera.

4. The video surveillance system provided under this scope of Work shall integrate seamlessly with the current video surveillance system deployed at existing DEP locations. All devices installed within this scope of Work shall be capable of being monitored/controlled locally at the Temporary and Permanent Shaft 18 Booths and remotely over the DEP WAN.

5. The Contractor shall be responsible for providing the necessary workstations under this scope of Work to allow for monitoring and control capabilities within the Temporary Shaft 18 Booth.

B. Functional Description

1. The primary functions of the VSS system shall be for alarm assessment, access control verification purposes, and general surveillance.

2. The system shall interface with the ACAM to provide camera call-ups of the alarm conditions. The VSS shall provide a pre-developed, tested and certified interface between ACAM and the VSS solution for alarm call-ups.

3. VSS cameras shall be IP-based and shall be capable of being powered via power-over-ethernet (PoE). However, all VSS cameras shall be powered over a dedicated, separate power supply.

4. Fixed VSS cameras and PTZ cameras shall be at a minimum, 2 megapixels high-definition quality color cameras with digital zoom capability, IR, and varifocal lenses.

5. All VSS cameras shall be provided with tinted domes, heaters, and in-line surge protectors.

6. All VSS camera licenses shall be provided with a three-year support agreement per device.

7. The License Plate Recognition System provided shall be capable of recording to and being monitored from the Pelco VideoXpert system within the Temporary Police Booth Control Room.

8. The IP-based Network Video Recorder (NVR) should have the ability to record continuously all VSS devices, including a 20% future capacity, for 60 Days at a minimum 15 fps, at the maximum resolution of the provided camera. This NVR must have a dual power-supply for resiliency and RAID6 storage.

9. The Network Video Recorder shall be equipped with the latest Pelco VideoXpert software available at the time of installation, and shall be provided with dual Network Interface Cards (NIC) for connections to both the CCTV 192 LAN and the DEP WAN. All cameras shall reside on the CCTV LAN.

10. The NVR shall be programmed by a certified installer. It shall be the responsibility of this Contractor to install and completely program all CCTV system equipment. This shall include but not be limited to; the network name of the NVR (coordinate through the Engineer System Administrator), camera Presets and default position, camera recording schedules and privacy blanking.

11. The Contractor must perform on-site and off-site (NYC DEP Police Precincts) installations, programming, adjustments and data-entry to the ESS including associated computer equipment, communication transmission equipment, data transmission media, local processors, and support equipment that will be monitored at the NYCDEP Police Command Centers.

12. An analysis should be conducted by the Contractor to optimize the operation of cameras. This shall include but not limited to the following:

    A. Area lighting and the sensitivity of cameras for proper viewing.

    B. Field of view to provide continuous and overlapping surveillance areas for cameras adjacent to each other to avoid blind spots.

    C. Data usage examination and means to decrease data storage during times of inactivity in specific areas.

13. All cameras shall have day and night viewing capabilities.

14. IR-illuminators shall be installed in areas where adequate lighting is not available for proper viewing. IR illuminators shall be capable of being powered via ethernet.

15. AN IP-based KVM device shall be installed to allow for both local and remote NVR access and control and must be installed on DEP's WAN.

16. The network switch shall have ports to accommodate the following equipment. Refer to Specification 27 21 29 for more requirements on the network switches.

    A. NVR (2-ports to reside on DEP LAN and WAN)

    B. UPS (WAN)

    C. IP cameras (LAN)

    D. IP-KVM (WAN)

    E. IP Power Strip (WAN)

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Not Used

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All devices are to be UL listed and approved for the use with which they are serving, unless otherwise noted or pre-approved by the Security Engineer.

B. Final selection of color and finish of product is to be per instruction of the Project Architect. If necessary, cameras are to be disassembled and painted per Project Architect and in alignment with device warranty requirements.

1. Video Management System

    A. Pelco VideoXpert

    B. No other brand is acceptable

2. Network Video Recorder
   A. Pelco VideoXpert Power 2 Server with 60 Days of storage at 15 fps and highest camera resolution. Storage calculation to be provided to the Engineer for review and approval. Refer to 28 05 00 for calculation requirements.
   B. No other brand is acceptable
3. Fixed IP Cameras
   A. Pelco Sarix IMP 3
   B. Or approved equal
4. PTZ IP Cameras
   A. Pelco Spectra Enhanced 7 Series 1080p
   B. Or approved equal
5. Camera Mounts
   A. As recommended by camera manufacturer
6. Infrared Illuminators
   A. Raytec VAR2-i8-1
   B. Or approved equal
7. License Plate Cameras
   A. NDI-RS-C320
   B. Or approved equal
8. License Plate Reader Processor
   A. NDI-RS SC-IV
   B. Or approved equal
9. Security Monuments
   A. Hoffman nVent
   B. Or approved equal
10. Camera Power Supply
    A. Altronix ALTV1224C
    B. Or approved equal
11. IP KVM
    A. Dominion KX-IV-101
    B. Or approved equal
12. Workstation

A. Pelco VideoXpert Professional Desktop Workstation VX-WKST

B. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. The system shall be installed by qualified technicians who have been factory trained and certified.

B. Wiring shall be uniform and in accordance with national electric codes and manufacturer's instructions.

C. Equipment shall be firmly secured, plumb, and level.

D. All splices shall be in easily accessible junction boxes or on terminal boards. Splices within any length of the VSS camera signal cable shall not be acceptable and will be rejected during testing and commissioning by the Engineer.

E. All cable runs at the main terminal board and in all junction boxes shall be tagged and identified.

F. Coordinate all Work with other effected trades and Contractors.

G. Where ceiling conditions allow (e.g. drop ceiling, tile ceiling, gypsum ceiling), installation of cameras shall be surface mounted.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Electrical Power

1. All AC power feeds to the system shall be installed in conduit separate from the data bus communication and low voltage control cables. The 120 VAC input power shall be furnished and installed by the Electrical Contractor.

The Security Contractor shall be responsible for coordinating their requirements with the Electrical Contractor.

2. The Security Contractor shall furnish and install, in accordance with the manufacturer's instructions, all interconnect wiring, and equipment necessary for the erection of a complete system as described herein and shown on the drawings. All wiring termination, except 120 VAC power inputs and above door finish hardware device inputs, shall be the responsibility of the Security Contractor.

B. System Initializing and Programming

1. All video surveillance management and recording software shall be provided, configured and programmed by the Security Contractor.

2. Cameras shall be adjusted and focused to achieve the field-of-views required and have been identified within the security drawings.

3. Cameras shall be adjusted and configured to address the lighting conditions of where the camera is installed.

4. The Security Integrator shall be responsible for providing field testing and monitoring equipment for adjusting and configuring the cameras. The intent of this field testing and monitoring equipment is to allow the installation and configuration of the cameras to proceed without reliance upon an active network being available.

C. System Testing

1. Fixed Cameras

A. Verify the field of view of the camera is per the requirements identified on the security drawings

B. Verify the image is clear and in focus

C. Verify the camera name and label is correct for the installed location

D. Verify the video is properly stored and can be played back

E. Verify the response time between camera selection and camera display. This should occur in under one-second.

F. For exterior cameras, verify image quality during three periods of the day (morning, afternoon, night)

G. Verify that any integrations with Electronic Security Sub-Systems or other building systems functions as specified (i.e. camera call-ups with ACAMS)

2. Performance Verification Test (PVT)

A. Once installed and configured, the associated equipment completely powered, and the controls checkout and initial operation, the

Contractor shall perform a Performance Verification Test (PVT) to verify that all equipment and programmed software is operating properly as a fully integrate system, and that the intended monitoring and control functions are fully implemented and operational. The Contractor must develop and submit a PVT test procedure for review and approval by the Engineer at least 30 Days prior to the start of the PVT. Any defects or problems found during the test shall be corrected by the Contractor and then re-tested to demonstrate proper operation.

3. Endurance Testing

A. 60-Day endurance test: A 60-Day endurance test period will commence after the system is accepted. Any issues considered by DEP-SEU to be critical to the operation and maintenance of the system that are detected during the 60-Day test period must be corrected promptly (within a week) by the Contractor. A new 60-Day endurance test period will begin following any corrective actions taken by the Contractor. During the endurance test, all punch list items must be addressed and fixed. Once punch list items are corrected, a subsequent walkthrough must be provided to demonstrate items were corrected. Any sequence of operation changed needed due to issues found during testing must be provided.

D. Waste Management

1. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish and install a fire detection and alarm system to include Fire Alarm Control Panels, smoke and heat detectors, horns with strobe lights, manual pull stations, and all other components required to provide a fully functional system.

B. An index of the Articles in this Section is presented hereinafter for the convenience of the Contractor.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

1.04 REFERENCES

A. NFPA 70, National Electrical Code

B. NFPA 72, National Fire Alarm and Signaling Code

C. NFPA 101, Life Safety Code

D. ADA 1990 and UL 1971 requirements

E. UL 864, 9th Edition

F. New York State Building Code

1.05 DESCRIPTION

A. This Section includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panels (FACP), Network Reporting Terminals (NRT), Network Liquid Crystal Display (NLCD), auxiliary control devices, annunciators, wiring and conduits as shown on the Contract Drawings and specified herein.

B. The fire alarm system shall comply with requirements of 2016 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this Specification. The system shall be electrically supervised and monitor the integrity of all conductors.

C. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001.

D. The FACP and peripheral devices shall be manufactured by a single manufacturer (or division thereof), in accordance with applicable U.S. industrial standards (i.e. NFPA, FM, etc.).

E. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) or central monitoring station and designated personnel in other buildings at the site via a multiplex communication or Digital Alarm Communicator Transmitter (DACT).

F. The FACPs shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the local fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal

at the local FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.

G. The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.

H. Basic Performance:

1. The connection between network control panels shall be Arcnet-based or other recognized network communication scheme and shall be wired in a Class A, Style 7 fashion.

2. Alarm and trouble signals from the FACP, NRT, and NLCD network nodes shall be digitally encoded by a listed electronic devices onto a NFPA Style 7 looped multiplex communication system.

3. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 4 (Class B) Signaling Line Circuits (SLC).

4. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).

5. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).

6. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).

7. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

8. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

9. Digitized electronic signals shall employ check digits or multiple polling.

10. Transponder devices are to consist of low current, solid-state integrated circuits, and shall be powered locally from a primary power and standby power source.

I. Network

1. A node may be an intelligent Fire Alarm Control Panel (FACP), Network Reporting Terminal PC (NRT) or an Intelligent Network LCD Annunciator (INA). The network shall be capable of expansion to at least 103 nodes. Each network node address point shall be capable of processing a minimum of 1,980 analog addressable points. Each network node address shall be software assignable at each node.

Systems which utilize a fixed network addressing scheme are not suitable substitutes. There shall be no limit to the types, mix, physical location or quantity of any node type below the overall limit of the network node capacity. In addition, each network node shall also act as a signal repeater to reshape and regenerate the network signal.

J. System Operation

1. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

   a. The FACP alarm LED on the FACP shall flash.

   b. A local piezo-electric signal in the FACP control panel shall sound.

   c. The 80-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.

   d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.

   e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

2. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

   a. The FACP supervisory LED on the FACP shall flash.

   b. A local piezo-electric signal in the FACP control panel shall sound.

   c. The 80-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the condition, including the type of point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.

d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.

e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

3. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The FACP trouble LED on the FACP shall flash.

b. A local piezo-electric signal in the FACP control panel shall sound.

c. The 80-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the condition, including the type of point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.

d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.

e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

K. Network Communication

1. The network architecture shall be based on a Local Area Network (LAN), a firmware package which utilizes a peer-to-peer, inherently regenerative communication format and protocol. The protocol shall be based on ARCNET or equal. The network shall use a deterministic token-passing method. Collision detection and recovery type protocols are not acceptable substitutes due to life safety requirements. In addition, there shall be no master, polling computer, central file computer, display controller or other central element (weak link) in the network which, on failure, may cause complete loss of network communications or cause major degradation of network capability. There shall be no cascading of CPUs or master-slave relationships at the network level to facilitate network communications. Failure of any node

shall not cause failure or communication degradation of any other node or change the network communication protocol among surviving nodes located within distance limitations. Each node/panel shall communicate on the network at a baud rate of not less than 312 KBPS (kilobits per second).

2. Each network node address shall be capable of storing Cooperative-Control-By-Event (CCBE) equations. The CCBE shall be used to activate outputs on one network node from inputs on other network nodes. The CCBE equation shall support the following minimum Boolean operators: AND, OR and NOT.

L. The Contractor shall provide the appropriate drawings with PE stamps for the Fire Department submittal and shall be responsible for all required filings/forms, inspections and final approvals required by the local AHJ.

1.06 QUALITY ASSURANCE

A. Manufacturer shall be specialized in furnishing the complete fire alarm system for at least five years.

B. Licensed Contractors - Only a New York State licensed electrical contractor shall install, alter, or repair electrical wiring or apparatus for fire alarm systems in any building.

C. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

D. Installer Qualifications: The design, programming, and on-site installation supervision shall be performed by personnel certified by NICET as a minimum of Fire Level IV Technician. The installation shall be performed by personnel certified by NICET as a minimum of Fire Level II Technician.

1.07 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

3. Show annunciator layout and main control panel module layout, configurations and terminations.

4. Include voltage drop calculations for notification appliance circuits.
5. Include battery-size calculations.
6. Include "Sequence of Operation."

C. Manuals:

1. Submit complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation which gives the information required to properly operate the equipment and system.

D. Certifications: Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.

1.08 DELIVERY, STORAGE, AND HANDLING

A. It is the Contractor’s responsibility to ensure on-time delivery of all materials and equipment required for the Project. All materials furnished or incorporated in the Work shall be new, unused, of best quality, and especially adapted for the service required; whenever the characteristics of any material are not particularly specified, such material shall be utilized as is customary in first class work of a nature for which the material is employed.

B. Contractor shall provide necessary means to properly stage and store all materials and equipment until time of use or installation on the Project. Contractor shall be solely responsible for materials and equipment stored on the Site; type and extent of security provided to be at Contractor’s discretion. Coordinate all requirements with Owner.

C. Contractor shall be responsible for proper handling, rigging, and installing of all materials and equipment for the Project.

D. Owner reserves the right to reject any materials or equipment that are not properly stored in accordance with these specifications or the manufacturers’ requirements.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall furnish and deliver to the client an additional ten (10) percent (minimum of 2) of the total smoke detectors, pull stations, horns with strobes and input/output modules, for replacement purposes as well as all the spare parts recommended by the manufacturer and approved by the Engineer,

all of which shall be identical and interchangeable with similar parts furnished under this Section.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. All spare parts shall be delivered neatly wrapped or boxed, indexed and tagged with complete information for use and reordering.

1.10 SPECIAL WARRANTY PROVISIONS / GURANTEE PERIODS

A. Not used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The fire detection and alarm systems shall be as manufactured by:

1. Notifier Fire Systems.
2. Edwards Systems Technology.
3. Cerberus Pyrotronics,.
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. Conduit and Wire

1. Conduit:
   a. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
   b. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.
   c. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760 136.
   d. Wiring for 24volt control, alarm notification, emergency communication and similar power limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
   e. Conduit shall not enter any FACP, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
   f. Conduit shall be 3/4 inch minimum.
2. Wire:
   a. All fire alarm system wiring must be new.
   b. Wiring shall be in accordance with local, state, and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and signaling line circuits, and 16 AWG for notification appliance circuits.
   c. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
   d. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
   e. Wiring used for the signaling line circuit (SLC) multiplex communication loop shall be twisted and shielded and installed

in conduit unless specifically excepted by the fire alarm equipment manufacturer.

f. All fire alarm wiring shall be completely supervised at the fire alarm control panel.

3. Network Media:

a. General: The network shall be capable of communicating via wire or fiber optic medium. The network shall also support the use of both wire and fiber in the same network (hybrid network). A wire network shall include a failsafe means of isolating the nodes in the unlikely event of complete power loss to a node. The failsafe design shall allow the network communications signal to bypass the failed node which allows the continuation of normal communications activity if specified wiring distances are maintained.

b. Network Repeater: A network repeater shall be available to increase the twisted pair distance capability in 3,000 ft. increments. As an option, a repeater shall be available for fiber optics which increases the wire distance in 10 dB increments. A mix (hybrid) fiber/wire network repeater shall also be supported. Systems which have distance limitations and have no available means to regenerate signals are not suitable substitutes.

c. Twisted Pair (wire) Communication: The dedicated twisted pair shall utilize 12 to 24 AWG wire and support distances of up to 3,000 ft between nodes.

4. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their intended purpose. Provide as specified in section 260533.

5. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

6. The FACP(s) shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The FACP cabinet shall be grounded securely to either a cold-water pipe or grounding rod.

E. Fire Alarm Control Panels and Fire Command Center

1. Each network FACP shall contain a microprocessor based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, transponders, local and remote operator terminals, printers, annunciators, and other system-controlled devices.
2. Each FACP on the network shall perform the following functions:
    a. Supervise and monitor all intelligent/addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
    b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to transponders.
    c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
    d. Visually and audibly annunciate any trouble, supervisory or alarm, condition on operator's terminal, panel display, and annunciators.
3. General FACP Operation:
    a. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha numeric keypad for field programming and control of the node.
    b. All programming or editing of the existing programing in the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
    c. Each FACP node shall be capable of providing the following features:
        - Block Acknowledge for Trouble Conditions
        - Rate Charger Control
        - Control By Time (Delay, Pulse, time of day, etc.)
        - Automatic Day/Night Sensitivity Adjust (high/low)
        - Device Blink Control (turn of detector LED strobe)
        - Environmental Drift Compensation (selectable ON or OFF)
        - Smoke Detector Pre alarm Indication at Control Panel
        - NFPA 72 Smoke Detector Sensitivity Test
        - System Status Reports
        - Alarm Verification, by device, with tally

- Multiple Printer Interface
- Multiple CRT Display Interface
- Non-Fire Alarm Module Reporting
- Automatic NFPA 72 Detector Test
- Programmable Trouble Reminder
- Upload/Download System Database to PC Computer
- One Man Walk Test
- Smoke Detector Maintenance Alert
- Security Monitor Points
- Alpha numeric Pager Interface
- Online or Offline programming

4. FACP Central Processing Unit (CPU):

   a. Each FACP network node shall include a central processing unit. The CPU shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.

   b. Each CPU shall contain and execute all control by event interlock for specific local and network action to be taken if an alarm condition is detected by the system. Control by event programs shall be held in nonvolatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.

   c. The central processing unit shall also provide a real time clock for time annotation of all system displays. The time of day and date shall not be lost if system primary and secondary power supplies fail.

5. Loop Interface Board (LIB):

   a. Loop interface boards shall be provided to monitor and control each of the Signaling Line Circuit (SLC) loops in the network node. The loop interface board shall contain its own microprocessor and shall be capable of operating in local mode in the case of a failure in the main CPU of the control panel. In local mode, the loop interface board shall detect alarms and activate output devices on its own SLC loop.

   b. The LIB shall not require any jumper cuts or address switch settings to initialize SLC Loop operations.

c. The loop interface board shall provide power to, and communicate with, all of the intelligent detectors and addressable modules connected to its SLC Loop over a single pair of wires. This SLC Loop shall be capable of operation as NFPA Style 4, Style 6, or Style 7.

d. The LIB shall be able to drive two Style 4 SLC loops, each up to 10,000 feet in length, for an effective loop span of 20,000 feet.

e. The loop interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The loop interface board software shall include software to automatically adjust and compensate for dust accumulation to maintain detector performance as it is affected by environmental factors. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

f. The LIB shall communicate with each intelligent addressable detector and addressable module on its SLC loop and verify proper device function and status. Communication with up to 198 intelligent devices shall be performed every 6 seconds or less.

6. Serial Interface Board (SIB):

a. The serial Interface board shall provide the EIA 232 interface between local FACP nodes and UL listed Electronic Data Processing (EDP) peripherals.

b. The SIB shall allow the use of multiple printers, CRT monitors, and other peripherals connected to the EIA 232 ports.

c. The serial interface board shall provide one EIA 485 port for the serial connection of optional annunciators and control subsystem components.

d. The SIB shall include LEDs which indicate that it is in regular communication with the annunciators and other EIA 485 connected peripheral devices.

e. All EIA 232 circuits shall be optically isolated, and power limited.

7. Enclosures:

a. Control panels shall be housed in UL listed cabinets suitable for surface or semi flush mounting. Cabinets shall be corrosion

protected, given a rust resistant prime coat, and the manufacturer's standard finish.

b. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right- or left-hand side.

d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

8. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.

9. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROMs are not acceptable.

10. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.

11. Each transponder and peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equal error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

12. FACP Power Supplies:

a. Main power supplies shall operate on 120/240 VAC, 50/60Hz, and shall provide all necessary power for the FACP.

b. Each main supply shall provide power circuits of 3.0 amps of usable notification appliance power, using a switching 24 VDC regulator.

c. The main power supply shall be expandable for additional notification appliance power in 3.0 ampere steps.

d. Each main power supply shall provide a battery and battery charger for 24 hours of standby using dual rate charging techniques for fast battery recharge. It shall charge at a minimum of 60 Amp hour batteries within a 48-hour period.

e. The supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

f. It shall provide meters to indicate battery voltage and charging current.

g. The main power supply shall be power limited per 1995 UL864 requirements.

13. Field Charging Power Supply: The FCPS is a device designed for use as either a remote 24-volt power supply or used to power Notification Appliances.

a. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0-amp hour batteries and to support 60 hour standby.

b. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.

c. The FCPS shall include an attractive surface mount backbox.

d. The Field Charging Power Supply shall include the ability to delay the AC fail delay per 1993 NFPA requirements.

e. The FCPS include power limited circuitry, per 1995 UL standards.

f. The Notification Appliance Circuits shall be synchronized.

14. System Circuit Supervision:

a. Each FACP node shall supervise all circuits to intelligent devices, transponders, annunciators, and peripheral equipment and annunciate loss of communications with these devices. The FACP CPU shall continuously scan the above devices for proper system operation and upon loss of response from a device shall

sound an audible trouble, indicate which device or devices are not responding and print the information on the printer.

b. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off normal position.

c. Transponders that lose communication with a FACP CPU shall sound an audible trouble and light an LED indicating loss of communications.

d. Transponder Circuit Supervision: Transponders shall be designed such that they continuously scan all of their initiating and notification circuits. With normal communications between the FACP and the transponders, the transponders shall transmit initiating and notification circuit trouble conditions to the FACP for audible annunciation and printout. With or without communication with the FACP node, the transponders shall supervise their circuits and annunciate any initiating circuit and notification circuit failures on LEDs located in the transponder.

15. Field Wiring Terminal Blocks: For ease of service, all wiring terminal blocks shall be the plug-in type and have sufficient capacity for 18 to 12 AWG wire. Fixed terminal blocks are not acceptable.

16. Operators Terminal: Provide the following functions in addition to any other functions required for the system.

a. Acknowledge (ACK/STEP) Switch:

- Activation of the control panel Acknowledge switch in response to a single new Alarm and/or trouble condition shall silence the local panel piezo electric signal and change the system alarm or trouble LED from flashing mode to steady ON mode. If additional new alarm or trouble conditions exist or are detected and reported in the system, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
- Depressing the acknowledge switch shall also silence all remote annunciator piezo sounders.

b. Signal Silence Switch: Activation of the signal silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm activation. The selection of notification circuits and relays which are silence able by this switch shall be fully field programmable within the confines of all applicable standards.

c. System Reset Switch: Activation of the system reset switch shall cause all local electronically latched initiating devices, software zones, output devices and circuits, to return to their normal condition. If an alarm condition(s) still exists, or if they reoccur in the system after system reset switch activation, the system shall then resound the alarm conditions.

d. System Test Switch: Activation of the system test switch shall initiate an automatic test of all intelligent/addressable detectors in the local system. The system test shall activate the electronics in each intelligent sensor, simulating an alarm condition and causing the transmission of the alarm condition from that sensor to the fire alarm control panel. The fire alarm control panel shall interpret the data from each sensor installed in the system. A report summarizing the results of this test shall be displayed automatically on the system LCD and on any CRTs or printers in the system.

e. Lamp Test Switch: Activation of the lamp test switch shall sequentially turn on all LED indicators, system liquid crystal display and local piezo signal, and then automatically return the fire alarm control panel to the previous condition.

17. Printer:

a. Printers shall be UL 864 listed and shall be an automatic type with code, time, date, location, category, and condition.

b. The printer shall provide hard copy printout of all changes in status of the system and shall time stamp such printouts with the current time of day and date. The printer shall be standard carriage with 80 characters per line. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association (EIA) standard EIA 232D. Power to the printer shall be 120 VAC 60 Hz.

c. Thermal printers are not acceptable.

18. Transponders:

a. Transponders shall be listed under UL category UOJZ as an independent, local fire alarm control unit as well as being listed as a critical component in a multiplex fire alarm system. Transponders shall be located where shown on the plans.

b. The transponder shall serve as the interface between initiating fire devices, controlled signaling devices, and each FACP node.

The supervised multiplex communication port shall be an integral part of the transponder.

c. Each transponder shall be powered from a local power supply, and shall provide all power necessary for its own operation, including standby power.

d. Transponders shall communicate with, and be controlled by, the host FACP via a 2-wire communications loop. The communications loop shall operate as an NFPA Style 4, Style 6 or Style 7 loop.

e. Transponders shall be used to house amplifiers, batteries, and power supplies to allow true distributed processing and amplification.

f. Each transponder shall have the following indicators and operator controls:

- Alarm Acknowledge/Reset Switch
- Power LED
- System alarm LED
- System trouble LED
- Local piezoelectric signal
- Red alarm per initiating device circuit
- Green on/off LED per notification appliance circuit or relay

g. Each transponder will be capable of expansion of up to 24 field circuits of the following types in any mix:

- Initiating Device Circuits (IDC): IDCs may be added to the transponder in groups of 8 Style B (Class B), or 4 Style D (Class A) circuits. Each circuit shall be capable of monitoring up to 30 compatible 2 wire smoke detectors, and/or any number of contact type initiating devices.
- Auxiliary Control Relay Outputs: Auxiliary relay outputs may be added to the transponder in groups of eight individually controlled single Form C circuits, or four dual Form C circuits. All Auxiliary circuits shall be rated 2 A. @ 30 VDC.

19. Field Programming:

a. The system shall be programmable, configurable and expandable in the field without the need for special tools or

electronic equipment and shall not require field replacement of electronic integrated circuits.

b. All local FACP node programming shall be accomplished through the FACP keyboard or through the video display terminal.

c. All field defined programs shall be stored in nonvolatile memory.

d. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Two levels of password protection shall be provided in addition to a key lock cabinet. One level is used for status level changes such as zone disable or manual on/off commands. A second (higher level) is used for actual change of program information.

20. Specific System Operation

a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.

b. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

c. System Point Operations:

- All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.
- Any FACP node output point may be turned on or off from the local system keypad or the video terminal

d. Point Read: The FACP node shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point will be annunciated for the parameters listed:

- Device Status
- Device Type
- Custom Device Label
- Software Zone Label
- Device Zone Assignments

- Detector Analog Value
- All Program Parameters

e. System Status Reports: Upon command from a password authorized operator of the system, a status report will be generated, and printed, listing all local FACP system status.

f. System History Recording and Reporting: Each FACP node shall contain a history buffer that shall be capable of storing a minimum of 400 system events. Each local activation will be stored, and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.

g. The history buffer shall use nonvolatile memory. Systems which use volatile memory for history storage are not acceptable.

h. Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

F. Network Monitoring Devices

1. Intelligent Network Annunciator:

a. An intelligent network annunciator shall be provided to display all system intelligent points. The INA shall be capable of displaying all information for all 200,000 possible points on the network. Network display devices which are only capable of displaying a subset of network points shall not be suitable substitutes.

b. The INA shall include a minimum of 80 characters, backlit by a long-life solid-state LCD display. The network display shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in an attractive

backbox designed for this use or may mount in an industry standard 19 inch (482.6 mm) rack. The network shall support over 103 network display annunciators (not to exceed total node capacity) and shall connect to the network over either a wire or fiber interface.

c. The intelligent network annunciator shall have a history buffer capable of storing a minimum of 400 events in nonvolatile memory.

d. The INA shall include two optically isolated, 2400 baud, industry standard EIA 232 ports for UL864 listed printers and CRTs. These peripheral devices shall print or display network activity.

e. The intelligent network annunciator shall include five control switches for system wide control of signal Silence, Reset, Activate Signals (Drill), and Lamp Test (local). A means by which the controls switches are "locked out", such as a key, shall be available.

f. The INA shall include long life LEDs to display Power, Fire Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, and CPU Failure.

g. The intelligent network annunciator shall include two software assignable passwords, up to five digits in length.

h. For time keeping purposes the INA shall include a time-of-day clock.

i. The intelligent network annunciator shall include the ability to interface to Motorola's Alert Central Paging system. With this option the INA shall have the ability to send every network event to the Alert Central. The Alert Central can then send the INA's complete 80-character message to select pocket pagers.

j. Each INA shall support up to 32 additional 80-character remote display annunciators for displaying network activity. These "Terminal Mode" displays will mimic the activity appearing on the corresponding INA.

G. System Components, Conventional

1. Programmable Electronic Sounders:

a. Electronic sounders shall operate on 24 VDC nominal.

b. Electronic sounders shall be field programmable without the use of special tools, to provide slow whoop, continuous, or

interrupted tones with an output sound level of at least 90 dBA measured at 10 feet (3 meters) from the device.

c. Shall be flush or surface mounted as show on plans.

2. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria.

a. The maximum pulse duration shall be 2/10 of one second.

b. Strobe intensity shall meet the requirements of UL 1971.

c. The flash rate shall meet the requirements of UL 1971.

3. Duct Smoke Detectors:

a. Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

4. Sprinkler and Standpipe Valve Supervisory Switches

a. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

b. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

c. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one fifth of the distance from its normal position.

d. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4-inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.

e. The switch housing shall be finished in red baked enamel.

f. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

g. Valve supervisory switches shall be provided and connected under this section and installed by other contractors.

H. System Components, Intelligent

1. Addressable Devices General

a. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.

b. Addressable devices which use a binary address setting method, such as a Dip switch, are not an allowable substitute.

c. Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the FACP signaling line circuit.

d. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

e. The fire alarm control panel shall permit detector sensitivity adjustment through field programming. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.

f. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

g. The detectors shall be ceiling mount and shall include a separate twist lock base with tamper proof feature. Base shall include a sounder base with a built in (local) sounder rated at 85 dBA minimum, a relay base and an isolator base designed for Class A applications.

h. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

i. Detectors shall also store an internal identifying code that the control panel shall use to identify the type of device (PHOTO, THERMAL).

j. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

k. Addressable devices shall provide address setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

l. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

2. Addressable Pull Box (manual station):

a. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

b. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

c. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

3. Intelligent Multi Detector:

a. The intelligent multi detector shall be an addressable device which is designed to monitor photoelectric, ionization, and thermal technologies in a single sensing device. This detector

shall utilize advanced electronics which react to smaller products of combustion found in fast flaming fires (ionization), slow smoldering fires (photoelectric), and heat (thermal) all within a single sensing device.

b. The multi detector shall include two bicolor LEDs which flash green in normal operation and turn on steady red in alarm

4. Intelligent Thermal Detector:

a. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate of rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

5. Hostile Area Smoke Detector:

a. The detector shall be designed to provide early warning smoke detection in environments where traditional smoke detectors are not practical.

b. The detector shall have a filter system to remove particles down to 25 microns.

c. This filter system shall remove unwanted airborne particles and water mist. This shall allow the detector to operate in environments where traditional smoke detectors would have nuisance alarms.

d. The filter system shall consist of 2 filters one of which is field replaceable.

e. The filter system shall have an intake fan to draw air and smoke through the filters into the sensing chamber.

f. The filter system shall be supervised so that if the filter is clogged or the fan fails the control panel reports trouble.

g. The filter system shall be powered from 24 VDC separate from the SLC communications.

h. The detector shall utilize a photoelectric sensing chamber

6. Addressable Dry Contact Monitor Module:

a. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

b. The monitor module shall mount in a 4-inch square, 2 1/8 inch deep electrical box.

c. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

d. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2 3/4-inch x 1 1/4 inch x 1/2 inch. This version need not include Style D or an LED.

7. Addressable Control Module:

a. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

b. The control module shall mount in a standard 4-inch square, 2 1/8 inch deep electrical box, or to a surface mounted backbox.

c. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

d. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.

e. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

8. Isolator Module:

a. Isolator modules shall be provided to automatically isolate wire to wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the

SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

b. If a wire to wire short occurs, the isolator module shall automatically open circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

c. The isolator module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

d. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

9. Serially Connected Annunciator Requirements:

a. The annunciator shall communicate to the fire alarm control node or INA via an EIA 485 (multi drop) two wire communications loop. The FACP node shall support two 6,000 ft. EIA 485 wire runs. Up to 32 annunciators, each configured up to 64 points, may be connected to connections, for a system capacity of 2,048 points of annunciation.

b. An EIA 485 repeater shall be available to extend the EIA 485 wire distance in 3,000 ft. increments. An optional (UL 864 listed) version shall allow the EIA 485 circuit to be transmitted over Fiber optics.

c. Annunciator switches may be programmed for system control such as, global acknowledge, global signal silence, global system reset, and on/off control of any control point in the system.

d. An optional module shall be available utilizing annunciator points to drive EIA 485 driven relays. This shall extend the system point capacity by 2,048 remote contacts.

10. LCD Alphanumeric Display Annunciator:

a. The alphanumeric display annunciator shall be a supervised, back lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.

b. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.

c. Up to 32 LCD annunciators may be connected to a specific (terminal mode) EIA 485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as, system acknowledge, silence, and reset.

d. LCD display annunciators shall mimic the local control panel 80-character display or network annunciator and shall not require special programming.

I. Batteries and External Charger

1. Battery:

a. Batteries shall be 12 volt, Gel Cell type.

b. The battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours quiescent plus 15 minutes of alarm upon a normal AC power failure.

c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.

J. Painting shall conform to the requirements of Section 09 91 00 - Painting. Finish color of fire alarm control panel, fire alarm conduits, fire alarm junction boxes and junction box covers shall be red.

2.03 FABRICATION / ASSEMBLY / FINISHES

A. Painting

1. Finish color of fire alarm control panel, fire alarm conduits, fire alarm junction boxes and junction box covers shall be red.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Source Limitations for Fire Alarm System and Components: Obtain fire alarm system from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the Contract Drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

E. Typical Operation: Actuation of any manual station, smoke detector, heat detector or waterflow switch, gas suppression system alarm, air aspiration system alarm shall cause the following operations to occur unless otherwise specified:

1. Actuate strobe units until the panel is reset.

2. Light the associated indicators corresponding to active speaker circuits.

3. Duct type smoke detectors shall, in addition to the above functions, shut down the ventilation system or close associated control dampers as appropriate.

4. Activation of any sprinkler system low pressure switch, valve tamper switch, gas suppression system trouble, air aspiration system trouble shall cause a system supervisory alarm indication.

3.03 FIELD TESTING / QUALITY CONTROL

A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

D. Verify activation of all flow switches.

E. Open initiating device circuits and verify that the trouble signal actuates.

F. Open signaling line circuits and verify that the trouble signal actuates.

G. Open and short notification appliance circuits and verify that trouble signal actuates.

H. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.

I. Ground initiating device circuits and verify response of trouble signals.

J. Ground signaling line circuits and verify response of trouble signals.

K. Ground notification appliance circuits and verify response of trouble signals.

L. Check alert tone and prerecorded voice message to all alarm notification devices.

M. Check installation, supervision, and operation of all intelligent smoke detectors using walk test.

N. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

O. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.04 STARTUP / DEMONSTRATION

A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

B. Instruction shall be required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

3.05 ADJUSTMENTS / PROTECTION / CLEANUP

A. Engage a factory-authorized service representative to train Owner's maintenance personal to adjust, operate, and maintain fire alarm system.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or Allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 13 34 23 - Fabricated Police Booth

B. Section 28 05 00 - Common Work Results for Electronic Security

C. Section 28 10 00 – Access Control and Alarm Monitoring

D. Section 28 20 00 - Video Surveillance System

E. Section 28 16 46 - Hostile Vehicle Control System

1.04 REFERENCES

A. Abbreviations and Acronyms:

1. Not Used

B. Reference Standards:

1. Not Used

1.05 DESCRIPTION

A. Description of Work

1. Provide a hands-free audio-video communication system, inclusive of video door stations and master stations
2. Provide ability to conduct 2-way audio communications between a master station and a door station, and between two master stations.
3. Provide ability for a master station to conduct a 1-way video assessment of door stations

B. Functional Description

1. The camera integrated within the door station shall be capable of being recorded onto the larger Video Surveillance System Network Video Recorder provided under this Division 28 scope-of-Work
2. The intercom system shall be capable of audible-visual communications between an individual at a door station and a staff member within the secure space, and remote visual identification of an individual at a door station by a staff member within the secure space.

A. Calls From Door Station to Master Station

1. A call request from a door station shall cause a corresponding LED to flash and a tone to sound on designated master(s), which shall cause an LED to light on the door station. In addition, the video captured by the integrated camera at the door station shall immediately start to display on the master station. The LED shall continue to flash and the tone shall sound intermittently until accepted and answered at the master. Once the call is answered by the master station, the LED on the door station shall be on continuously. All video door stations shall call the master intercom station located within the Police Booth Control Room.

B. Call Acceptance at Master(s)

1. Pressing the answer button shall initiate a “call-connect tone” to the selected door station shall cause the associated LED to illuminate steady, silence the audible tone, establish

an audio connection to the door station, and cause a green LED to light at the door station. The video captured by the door station shall be displayed on the intercom master unit.

C. Call from Master to Door Station

1. A call may be initiated at a master station at any time by simply pressing the appropriate direct-select button. Operation shall be as described above. If the door station is already connected to a master, the second master shall receive a short busy tone and no connection is made.

3. The door station and master station shall be capable of PoE. If additional power is needed for the devices, the Contractor shall be responsible for coordinating these additional requirements with the Electrical Contractor.

4. The devices shall be capable of background noise cancellation

5. The door station device shall be dirt, dust, and water resistant, and rated for use in exterior conditions experienced in Valhalla, NY.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Not Used

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All devices are to be UL listed and approved for the use with which they are serving, unless otherwise noted or pre-approved by the security Engineer.

B. Final selection of color and finish of product is to be per instruction of the Project Architect. If necessary, cameras are to be disassembled and painted per Project Architect and in alignment with device warranty requirements.

1. Video Intercom Door Station

a) Aiphone IX-DVF-L

b) Or approved equal

2. Video Intercom Master Station
    a) Aiphone IX-MV7-HB
    b) Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. The system shall be installed by qualified technicians who have been factory trained and certified.

B. Wiring shall be uniform and in accordance with national electric codes and manufacturer's instructions.

C. Equipment shall be firmly secured, plumb, and level.

D. All splices shall be in easily accessible junction boxes or on terminal boards. Splices within any length of the VSS camera signal cable shall not be acceptable and will be rejected during testing and commissioning by the Engineer.

E. All cable runs at the main terminal board and in all junction boxes shall be tagged and identified.

F. Coordinate all Work with other effected trades and Contractors.

G. Where ceiling conditions allow (e.g. drop ceiling, tile ceiling, gypsum ceiling), installation of cameras shall be recessed mount.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Electrical Power

1. All AC power feeds to the system shall be installed in conduit separate from the data bus communication and low voltage control cables. The 120 VAC input power shall be furnished and installed by the Electrical Contractor. The Security Contractor shall be responsible for coordinating their requirements with the Electrical Contractor.

2. The Security Contractor shall furnish and install, in accordance with the manufacturer's instructions, all interconnect wiring, and equipment necessary for the erection of a complete system as described herein and shown on the drawings. All wiring termination, except 120 VAC power inputs and above door finish hardware device inputs, shall be the responsibility of the Security Contractor.

B. System Initializing and Programming

1. All video surveillance management and recording software shall be provided, configured and programmed by the Owner.

2. Cameras shall be adjusted and focused to achieve the field-of-views required and have been identified within the security drawings.

3. Cameras shall be adjusted and configured to address the lighting conditions of where the camera is installed.

4. The Security Integrator shall be responsible for providing field testing and monitoring equipment for adjusting and configuring the cameras. The intent of this field testing and monitoring equipment is to allow the installation and configuration of the cameras to proceed without reliance upon an active network being available.

C. System Testing

1. As indicated in Section 1.05B.2.

2. Performance Verification Test (PVT)

A. Once installed and configured, the associated equipment completely powered, and the controls checkout and initial operation, the Contractor shall perform a Performance Verification Test (PVT) to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. The Contractor must develop and submit a PVT test procedure for review and approval by the Engineer at least 30 Days prior to the start of the PVT. Any defects or problems found during the test shall be corrected by the Contractor and then re-tested to demonstrate proper operation.

3. Endurance Testing

A. 60-Day endurance test: A 60-Day endurance test period will commence after the system is accepted. Any issues considered by

DEP-SEU to be critical to the operation and maintenance of the system that are detected during the 60-Day test period must be corrected promptly (within a week) by the Contractor. A new 60-Day endurance test period will begin following any corrective actions taken by the Contractor. During the endurance test, all punch list items must be addressed and fixed. Once punch list items are corrected, a subsequent walkthrough must be provided to demonstrate items were corrected. Any sequence of operation changes needed due to issues found during testing must be provided.

D. Waste Management

1. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

END OF SECTION

SECTION 31 05 19 – GEOSYNTHETICS FOR EARTHWORK
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for geotextiles used for separation of dissimilar aggregate or soil materials.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

A. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

B. New York State Department of Transportation (NYSDOT) Standard Specifications Section 737-01 GEOTEXTILES Table 737-01B

1.05 DESCRIPTION

A. Contractor shall provide and place geotextiles.

1.06 QUALITY ASSURANCE

A. Geotextile manufacturer shall be a specialist in manufacture of separation geotextiles.

B. Mill certificate that can confirm the geotextile meets chemical, physical, and manufacturing requirements stated in this specification shall be provided. The mill certificate shall be signed by a legally authorized official from the manufacturer.

1.07 SUBMITTALS

A. Submit product data including name of the manufacturer, product name, style number, chemical composition of the filaments or yarns and other pertinent information to fully describe the geotextiles.

B. Qualification Data: Resumes or documentation of experience for the following individuals or companies identified in the Quality Assurance requirements to demonstrate the experience requirements are met:
1. Geotextile Manufacturer
2. Geotextile Installation Supervisor

C. Submit Certifications specified in the Quality Assurance requirements.

D. Instructions and details describing and showing installation of geotextiles shall be submitted.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Ensure geotextiles labeling, shipment, and storage follows ASTM D4873. Ensure product labels clearly show the manufacturer or supplier name, style name, and roll number.

B. Store geotextiles rolls in a location elevated off the ground and adequately covered to protect them from the following: shipment, site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextiles.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Geotextiles must be composed of long-chain synthetic fiber of at least 85 percent, by weight, polyolefins or polyesters. Geotextiles must be capable of resisting degradation from chemicals, mildew, rot, and ultraviolet (UV) light.

B. Geotextiles must meet the relevant minimum physical property requirements shown in Table 737-01B of NYSDOT Specification Section 737-01.

Table 1 NYSDOT Specification Section 737-01 Table 737-01B

TABLE 737-01B SEPARATION GEOTEXTILE REQUIREMENTS										
Application	Geotextile Structure	Minimum Strength Class Requirements					Separation Class Requirements			
							Class	Apparent Opening Size (maximum)		Minimum Permittivity (sec^{-1})
		Class	Percent Elongation (%)	Grab Strength (lbf)	Tear Strength (lbf)	Puncture Strength (lbf)		Sieve Size (in.)	Sieve Designation	
Geotextile Separation	Any type listed in §737-01 Scope	2	< 50%	247	90 [1]	495	NA (X)	0.0234	No. 30	0.02
			≥ 50%	157	56	309				

Table 737-01B Notes:
[1] For woven monofilament geotextiles the minimum average value is 56 lbf.

C. Geotextile Drainage. Geotextile drainage shall meet the requirements of Table 737-01C.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Ensure geotextiles Manufacturer's testing is performed at a laboratory accredited by GAI-AP and A2LA for tests required for the geotextiles, at frequency meeting or exceeding ASTM D4354.

B. Ensure Ultraviolet Stability for proposed geotextiles has been verified by an independent laboratory on the geotextiles or geotextiles of similar construction and yarn type.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Contractor shall examine the conditions of the geotextiles to be installed and notify the Engineer any detrimental conditions that will affect proper and timely

completion of the work. Work shall not be proceeded until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install Geotextile at the proper location and elevation as shown on the approved Shop Drawings.

B. Geotextiles may be joined by sewing, using adhesive or overlapping. For geotextiles jointed by sewing, double sewn with nylon or polypropylene thread should be used and seams shall be lapped a minimum of 4 in. Strength of the seam shall be equal to the strength required for the geotextile.

Geotextiles that are joined using adhesive shall have a minimum overlap of a minimum of 4 in. Overlapped seams shall be lapped a minimum 20 in.

C. The Geotextile shall be placed in close contact with the soil. The Geotextile shall be laid loosely so that it will not get stretched or torn. The geotextiles shall be installed smoothly and free of tension, stress, folds, wrinkles, or creases.

D. Geotextiles shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sunlight for more than 15 days.

E. Temporarily secure geotextile in-place with staples, pins, sandbags or backfill as necessary taking account of fill properties, fill placement procedure and weather conditions.

F. At the time of installation, geotextiles with defects, rips, holes, flaws, deterioration or damage shall be rejected.

3.03 FIELD TESTING / QUALITY CONTROL

A. At a minimum, include the following items in the Inspection Plan:

1. Surveillance:
   a. Proper handling and storage of geotextiles.
2. Hold Point:
   a. Correct elevation, position of geotextile prior to fill placement.

B. Special Inspection: Provide access for the Special Inspector to perform independent quality control activities as follows:

1. Inspection of installation of geotextiles.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all equipment, tools, materials and labor necessary to install, protect, maintain, replace/repair if damaged, monitor, and remove geotechnical and structural monitoring instrumentation.

B. Requirements for monitoring of vibrations associated with rock excavation using drill and blast method are provided in Section 31 70 20 – Controlled Blasting.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 14 00 – Work Restrictions

B. Section 31 23 16 – Excavation

C. Section 31 23 25 – Rock Excavation

D. Section 31 70 20 – Controlled Blasting

1.04 REFERENCES

A. Definitions

1. Baseline Reading: Value of instrument reading(s) taken prior to construction activities that will affect the parameters to be measured by the instrument to provide a consistent, repeatable, established baseline against which all subsequent readings (Limit 1 and Limit 2 levels) are compared.

2. Central Data Management (CDM) System: A computerized system encompassing a database server and web server set up and maintained by the Contractor to process, store, and distribute geotechnical instrumentation data via a limited access website. The system shall also be capable of sending out automated alert messages (text, email) to a distribution list when instruments reach predefined response values. The Engineer shall be granted access to the system.

3. Crack Monitor (CM): Instrument placed on structures to allow measurement of horizontal and vertical movement over time.

4. Geophone: Refer to Section 31 70 20 – Controlled Blasting for definition

5. Ground Deformation Monitoring Point (GDMP): Marker or point fixed into the ground surface and monitored by optical survey method to determine the vertical and horizontal movements of ground adjacent to structure or facility being monitored that may occur during construction.

6. Groundwater Monitoring Point (GWP): Monitoring point installed with Vibrating Wire Piezometers (VWPs) to measure water pressure at various depths and to determine groundwater head and pore pressures. Includes measurement devices and appurtenant equipment, sensors, cabling, readout devices, and data loggers. Also includes ancillary facilities required for operation of these devices, such as casings, enclosures, housings, and covers

7. Optical Survey Target (OST)/Prism (PR): An instrument consisting of a survey target device mounted on the surface of a structure or facility to monitor horizontal and vertical movements during construction using an optical survey method and any other required supplemental method as approved.

8. Pavement Deformation Monitoring Point (PDMP): Masonry nail into the pavement and monitored by optical survey method to determine the vertical and horizontal movements of pavement adjacent to the construction activities.

9. Peak Particle Velocity (PPV): Refer to Section 31 70 20 – Controlled Blasting for definition.

10. Seismograph: Refer to Section 31 70 20 – Controlled Blasting for definition.

11. Structural Deformation Monitoring Point (SDMP): A control point consisting of an OST, non-destructively and firmly attached or established on structure or facility, used to monitor vertical and horizontal movement of a structure or facility that may occur during construction.

12. Utility Monitoring Point (UMP): Monitoring point that measures vertical and horizontal deformation of selected utilities.

13. Vibration Monitoring Point (VMP): Monitoring point that measures velocities of the ground vibrations resulting from construction activities. Measurement shall be by use of Seismographs.

B. Referenced Standards:

1. American Society for Testing and Materials (ASTM) Publications:

a. A403: Specification for Wrought Austenitic Stainless Steel Piping Fittings.

b. A53: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

c. C150: Specification for Portland Cement.

d. D1785: Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

1.05 DESCRIPTION

A. Contractor shall submit proposed locations of the instruments for geotechnical and structural monitoring during construction for approval by the Engineer. Locations of instrumentation include, but are not limited to, locations to be determined during construction as specified in Table 1. Additional requirements for instruments used for monitoring of blasting operations are included in Section 31 70 20 – Controlled Blasting.

B. The number of instruments to be provided at the Kensico site shall be in accordance with Table 1 below. All instrumentation for monitoring of ConEd facilities shall be in accordance with Section 01 14 00 - Work Restrictions.

Table 1 – Number of Instruments for Kensico Site

Location	CM	GDMP	GWP	PDMP	SDMP	UMP	VMP
LEC	2	-	-	-	2	-	1
UEC	1	-	-	-	1	-	-
Lab Building	2	-	-	-	2	-	1
Fluoride Building	1	-	-	-	1	-	-
Waterfowl Building	1	-	-	-	1	-	-
Shaft 18	1	-	-	-	1	-	-
Shaft 18 Flow Control Structure & 52" Stormwater Drain	-	4	-	-	-	4	-
Aerator Road	-	2	-	2	-	-	-
Columbus Avenue	-	-	-	6	-	-	-
Westlake Drive	-	6	-	6	-	-	-
Site Ground	-	16	8	-	-	-	-
Dike Grade Tunnel	-	2	-	-	-	2	1
Utilities within Kensico Site	-	-	-	-	-	16	-
Valhalla High School	2	2	-	-	2	-	2
ConEd Towers (D109 & D110)	-	-	-	-	2	-	2
Other Locations TBD	5	6	2	2	8	8	6
Total	15	38	10	16	20	30	13

C. Make initial instrument readings, monitor, reduce data, and submit records to the Engineer. The Engineer, at his/her discretion, may make additional instrument readings using the same readout instruments used by the Contractor.at

D. The data from all geotechnical instrument monitoring shall be placed on the CDM system.

E. Employ a Geotechnical Instrumentation Engineer (GIE) who will review and interpret the geotechnical instrumentation monitoring results on a daily basis and report to the Engineer when threshold value limits are exceeded and ensure that all notifications are made, and contingency plans are implemented. The Contractor

shall implement remedial and precautionary measures as required based on the monitoring results.

F. The monitoring work related to surface excavation in rock using drill and blast method, if required, shall be performed in accordance with the requirements in Section 31 70 20 – Controlled Blasting.

G. The monitoring work specified in this Section shall consist of, but is not limited to, the following:

1. Provide all personnel, materials, instruments and equipment and perform all operation necessary for supplying, installing, maintaining, and monitoring of instruments to record the following while performing the Contract Work:
    a. Movement of structures and facilities using optical survey or supplemental methods specified herein.
    b. Movement of ground adjacent to structures and facilities using optical survey or supplemental methods specified herein.
    c. Vibration monitoring by Seismograph as specified in Section 31 70 20 – Controlled Blasting.
    d. Crack monitoring.
    e. Utility monitoring.
2. Performing repairs and/or replacements of instruments damaged during performance of the Contract Work, at no additional cost to DEP, and removing instruments or handover instruments upon completion of the Contract Work, as directed by the Engineer.
3. Submitting monitoring data reports as specified herein, and when movements and vibrations reach or exceed trigger levels; send alert messages as specified herein.
4. Submit to the Engineer for approval all precautionary measures or remedial action plans that the Contractor would implement for the following: to limit vibrations and structural and ground movements; and in an event any trigger levels as specified in this Section are reached or exceeded.
5. Implementing approved precautionary measures or remedial action plans and then continue performance of the Contract Work.

H. Vibration monitoring:

1. The Contractor shall discuss in detail his/her selected means, methods, sequence of work and execution of the Contract Work with the GIE and shall jointly prepare a complete list of all the construction activities, that will induce construction vibrations at the sites.

2. The Contractor and GIE jointly shall evaluate complete list discussed above and prepare a selected list of construction activities that will induce vibrations in ground and could have damaging effect on the Contract Work. Based on the selected list, GIE shall prepare and submit a vibration monitoring plan for approval which includes placement of additional SDMPs and VMPs identified as TBD on Table 1. Vibration monitoring plans shall also include details of the Contractor's means, methods, sequence of work and execution of the Contract Work; details of complete and selected list as discussed above, and basis of preparation of selected list.

3. For vibration monitoring, Seismograph readings shall be collected from locations as approved by the Engineer. The Seismographs shall be located on ground or surface structure nearest to the area where active construction activities inducing vibrations are being performed. Seismograph locations shall be as per approved vibration monitoring plans or as directed by the Engineer.

4. The vibration monitoring for blasting Work is specified in Section 31 70 20 – Controlled Blasting.

I. If any structure, facility or utility, within and adjoining the Project Site, is damaged and is affected by Contract Work, the Contractor shall repair or replace with the same materials, as approved and as directed by the Engineer and at no additional cost to the City.

1.06 QUALITY ASSURANCE

A. The installation, calibration, and data collection; and analysis of results from the instrumentation systems, shall be performed by the GIE employed by the Contractor. The GIE shall be a licensed Professional Engineer registered in the State of New York, with a minimum of a bachelor's degree in civil engineering, and at least 10 years of experience in design, installation and monitoring of the types of instruments specified herein, and shall have had experience on at least two projects involving structural and geotechnical monitoring. The GIE shall directly supervise the Work specified in this Section.

B. The Contractor shall retain the services of a licensed Land Surveyor registered in the State of New York with a minimum of 5 years of experience in performing the type of survey work as specified in this Section.

C. Utilize the Vibration Specialist specified in Section 31 70 20 – Controlled Blasting to conduct monitoring of all vibration producing construction operations including all other vibration producing construction operations. The consultant shall notify the Engineer when the vibration limits specified in Table 3 are exceeded and the Contractor shall meet with the Engineer and implement changes to his construction operations to reduce vibrations to below the specified limits.

D. The GIE shall directly supervise the following Contract activities:

1. Evaluate the scope of the instrumentation program required by the Contract Documents and expand if warranted based on the Contractor's evaluation of subsurface conditions and the Contractor's means and methods for performing the Work.
2. Establish the layout and procedures for monitoring of optically surveyed instrumentation with a Licensed Land Surveyor in the State of New York.
3. Prepare detailed step-by-step procedures and schedule with bar charts for the installation of all instruments specified herein.
4. Be on-site to inspect and log soil and rock from the first five boreholes where in-ground instruments are to be installed and provide training to Contractor personnel to ensure that all subsequent boreholes are properly logged.
5. Be on-site, supervise, and conduct the pre-installation and post-installation acceptance tests of each type of instrument.
6. Be on-site and supervise at least the first five installations of each type of instrument.
7. Supervise interpretations of geotechnical instrumentation data.

E. Employ drilling and vacuum excavation subcontractors to install the geotechnical instruments. The drilling and vacuum excavation subcontractor shall have the following qualifications:

1. Have a minimum five years of experience in installation of geotechnical instruments of similar type and complexity as the proposed instruments and possess the New York State Dig Safe certification.
2. The Superintendent and/or Foreman shall have at least three years of experience in the installation of geotechnical instruments and has previously installed not less than five projects of equal type and complexity as the proposed instruments. The Superintendent and/or Foreman shall be present at the job site during the entire time of installation of instruments.

F. Readings of the geotechnical instruments shall be taken by the same personnel over the life of the project. Should a person need to be replaced, a minimum of two readings shall be carried out by both the person being replaced and his/her replacement to ensure consistent readings.

G. Readings of the geotechnical instrument shall have an accuracy of ±0.01 ft. for horizontal location and ±0.005 ft. for elevation.

H. Damaged geotechnical instrumentation shall be replaced by the Contractor within 24 hours at the Contractor's cost.

I. All readout instruments shall be calibrated at the manufacturer's facility within three months prior to use.

1.07 SUBMITTALS

A. Within ninety (90) days of Notice to Proceed of the Contract, the Contractor shall submit the following to the Engineer for review and approval:

1. Personnel's Qualification:

a. Resume of the GIE

b. Resume of the licensed Land Surveyor

c. Resume of drilling and vacuum excavation subcontractor.

2. Proposed instrumentation and monitoring plan showing locations of instrumentation as required in Table 1.

3. Instrument details, methods of installation and details of protection for instruments.

4. Schedules for instruments, surveying, data recording, data reporting, and instrument removals.

5. Certifications of instruments shall be provided to indicate that the manufacturer's test equipment is calibrated and maintained in accordance with the test equipment manufacturer's calibration requirements.

B. Survey records of each monitoring point reading shall be submitted no later than one (1) day after monitoring points are constructed and readings are taken. Monitoring records thereafter shall include list of monitoring points with initial and interim coordinates and elevations, and cumulative movement, both vertical and horizontal for each point surveyed. The Contractor shall submit entire history of monitoring record in both data table and graphs form as approved by the Engineer.

C. While performing the Contract Work at site, when any structural or ground movements, or vibration magnitudes reach or exceed trigger levels, send alert messages as specified in this Section and Section 31 70 20 – Controlled Blasting. The alert messages shall include the identification of the instrument(s) reaching or exceeding a trigger level(s), the date and time of reading, the value of the reading in engineering units, and the trigger level(s) reached or exceeded.

D. Submit all precautionary measures or remedial action plans that Contractor would implement for the following; to limit vibrations and structural and ground movements; and in an event any trigger levels as specified in this Section are reached or exceeded.

E. Submit updated as-built instrument location plans to the Engineer. The location plans shall be reproducible composite plans of all installed instruments prepared at a proper scale. The first plans shall be submitted within one month after completion of the first instrument installation, regardless of instrument type. Updated plans shall be submitted every subsequent four weeks. Updated plans need not be submitted for periods during which no instruments have been installed.

F. Submit design calculations, Shop Drawings, material specifications and method statement for support, protection and repair systems required for structures, facilities and finish; which are affected or damaged during performance of Contract Work; prepared, signed and sealed by a Professional Engineer registered in the State of New York employed by the Contractor for Engineer approval.

G. The certificate of Seismograph calibration performed by the manufacturer shall be submitted two weeks prior to the start of vibration monitoring Work at a Site. Subsequently, Seismograph calibration certificate performed by the manufacturer shall be submitted at least twice a year for the duration of the Contract.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. All materials and instruments shall be new.

B. Cement Grout: The cement grout shall be a mixture of 5.2 gallons of water per each 94-pound sack of Type II Portland cement in accordance with ASTM C150.

C. Surface protection shall be flush with the ground surface in paved or ground areas. For all instruments, provide roadway boxes with a 5-¼ inch lock lid as manufactured by Tyler Pipe, Tyler, TX, or Bresnahan Foundry, Hatfield, MA, or approved equal. Roadway boxes for inclinometers shall either have a diameter adequate to allow attachment of cable support assembly or shall allow for attachment of an inclinometer casing extension while readings are being taken.

Roadway boxes for utility monitoring points, inclinometers, and DMPs shall be as shown on the drawings and shall be 2 feet in length as a minimum.

D. Deformation Monitoring Points (DMPs – GDMPs, PDMPs, SDMPs):

1. Deformation monitoring points (DMPs) will be used to monitor vertical and horizontal deformation of various facilities at selected locations as indicated.

2. Provide materials for three types of DMPs as indicated on the Contract Drawings including SDMPs, GDMPs, and PDMPs.

E. Portable Seismographs (VMPs, with Geophones and microphones) as specified in Section 31 70 20 – Controlled Blasting.

F. Crack Monitors (CMs):

1. Provide crack monitors (CM) consisting of two overlapping acrylic plates as manufactured by Avongard, Santa Monica, CA or approved equal. Crack monitor shall be graduated in 1.0 mm intervals, a maximum width movement of 0.750 in., and a maximum upward movement of 0.375 in.

G. Crack Meters

1. If used, Crack Meters shall be model 4420 manufactured by Geokon, Inc., Lebanon, NH or an acceptable model by Geonor, Inc. Milford, PA, or an acceptable model by DGSI Slope Indicator, Mukilteo, WA or approved equal.

H. Utility Monitoring Points (UMPs):

1. Utility monitoring points (UMPs) will be used to monitor vertical and horizontal deformation of selected utilities as indicated on the Contract Drawings.

2. Provide materials for UMPs as indicated on the Contract Drawings.

a. Provide steel pipe flange, 1 inch in diameter, ASTM A403, machined to fit within 3-1/2 inch extra strong steel pipe sleeve.

b. Provide 3-1/2 inch extra strong steel pipe sleeve and 1-inch extra strong steel riser pipe, threaded and coupled, ASTM A53 Grade B.

c. Provide PVC centralizers. Centralizers shall consist of a schedule 40 PVC pipe conforming to ASTM D1785, sized to provide a tight fit on the riser pipe, and spring-formed to a larger diameter to provide a loose fit in the sleeve pipe.

d. Provide 18-inch x 18-inch x 1/4-inch steel plate with 4-1/4-inch diameter central hole.

e. Provide steel pipe clamp to fit 3-/12 inch extra strong steel pipe. Steel plate and pipe clamp assembly shall be capable of transferring the total weight of the 3-1/2 inch extra strong steel pipe sleeve to the soil underlying the steel plate. The assembly shall also be capable of maintaining its position on the 1-inch extra strong steel riser pipe over time.

f. Provide 1-inch pipe cap with 1/4-inch diameter round head stainless steel bolt set securely in cap.

I. Groundwater Monitoring Points (GWPs)

1. Groundwater monitoring points (GWPs) will be used to monitor groundwater pressures at selected locations as indicated on the Contract Drawings. GWPs include both new and existing instrumentation installed by previous Contracts required monitoring during construction.

2. Provide materials for GWPs as indicated on the Contract Drawings:

a. Vibrating Wire Piezometers (VWPs) shall be Slope Indicator Model 5261050 or equal.

b. Provide 4-channel vibrating wire data logger as manufactured by Geokon Inc. or approved equal. The data logger shall remain the property of the City

c. Roadway box shall be able to withstand the anticipated maximum construction loading, sized to encompass the casing, data logger, and cables. It should be freely drained at the bottom.

d. The aboveground data logger enclosure shall be nonmetallic fiber glass enclosure with bolted lid, waterproofed to prevent ingress of water into the enclosure, protected from weather, and rated for outdoors

J. Protective Barrier for Instruments:

1. Provided protective barrier and install at locations requiring protection for instrumentation to prevent damage caused by vehicles and construction equipment.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Pre-installation acceptance tests: When instruments are received at the installation site, the Contractor's instrumentation personnel shall perform pre-installation acceptance tests to ensure that the instruments and readout units are functioning correctly prior to installation. Pre-installation acceptance tests shall include relevant items from the following list:

1. Examine factory calibration curve and tabulated data, to verify completeness.
2. Examine manufacturer's final quality assurance inspection check list, to verify completeness.
3. Check cable length.
4. Check tag numbers on instrument and cable.
5. Check, by comparing with procurement document, that model, dimensions and materials are correct.
6. Bend cable back and forth, at point of connection to instrument, while reading the instrument, to verify connection integrity.
7. Verify that all components fit together in the correct configuration.
8. Check all components for signs of damage in transit.
9. Check that quantities received correspond to quantities ordered.

B. During pre-installation acceptance testing of each instrument the Contractor's instrumentation personnel shall complete a pre-installation acceptance test record form.

C. An instrument that fails the specified pre-installation acceptance test shall be repaired such that it passes a subsequent pre-installation acceptance test, or shall be replaced by an identical instrument at no additional cost to the City.

D. Scheduling Work:

1. Install instruments and agree to formal initial readings (FIR) in accordance with the following schedule:
   a. Deformation monitoring points shall be installed and formal initial readings agreed upon by the Engineer at least 30 days prior to any excavation activities.
   b. Utility monitoring points shall be installed and formal initial readings agreed upon by the Engineer at least 30 days prior to any excavation activities.

c. Crack monitors shall be installed and formal initial readings agreed upon by the Engineer at least 30 days prior to any excavation activities.

d. Vibration monitoring equipment shall be installed and tested as specified in Section 31 70 20 – Controlled Blasting, and to establish formal initial background readings agreed upon by the Engineer at least 30 days prior to any vibration inducing activities.

e. Groundwater monitoring points shall be installed and formal initial readings agreed upon by the Engineer at least 30 days prior to any excavation activities.

2. Timing of the installation of all monitoring equipment shall coordinate closely with the Contractor's schedule.

3.02 INSTALLATION

A. Installation – General

1. The Contractor's instrumentation personnel shall install instruments in accordance with the Contractor's detailed step-by-step procedures that were submitted as specified in this Section and reviewed by the Engineer.

2. Grout shall be placed using a tremie method with side discharge ports on the tremie pipe.

3. Prior to installing any instrument through drill casing, all material adhering to the inside of the casing, and all cuttings, shall be removed thoroughly.

4. Whenever withdrawing drill casing during instrument installation in a borehole, care shall be taken to minimize the length of unsupported borehole and the rate of casing or auger withdrawal. Collapse of the borehole shall not be allowed to occur. Backfill material shall not be allowed to build up inside the casing or auger such that the instrument is lifted as the casing or auger is withdrawn. The casing shall be withdrawn without rotation. The casing may be omitted, if allowed by the Engineer, only where it can be shown that instrument installation without the casing or auger will not cause collapse of the borehole or in any way adversely affect instrument installation. If casings are omitted, or the Engineer allows withdrawal of casings prior to instrument installation, the following requirements shall apply. The instrument shall be installed in the borehole in a continuous operation, starting when instrumentation materials are first placed in the borehole, and shall not be interrupted prior to complete backfilling of the borehole to the ground surface. Partially completed instrument installations shall not be left in unsupported boreholes overnight or longer without the prior written concurrence of the Engineer.

5. The Contractor shall notify the Engineer at least 24 hours prior to installing each instrument.
6. As each instrument is installed, an installation record sheet shall be prepared.
7. An instrument that fails the specified post-installation acceptance test shall be replaced by an identical instrument at no additional cost to the City.
8. After installation, roadway boxes shall be free-draining. Roadway boxes that are not free draining shall be repaired or replaced at no additional cost to the City.
9. Do not operate any construction equipment including trucks, dozers, scrapers, excavators, loaders, and cranes within five (5) feet of all geotechnical instruments.

B. Geotechnical Instrumentation Installation

1. Installation of Deformation Monitoring Points (DMPs – GDMPs, SDMPs, PDMPs)
    a. Deformation monitoring points (DMPs) shall be installed at the locations indicated on the approved instrumentation and monitoring plan or as directed by the Engineer. SDMPs will typically be installed into vertical surfaces of structures or buildings. PDMPs will typically be installed on pavements or painted targets on top of manhole rims. SDMPs drilled holes shall be located to avoid significant design features of the structure. GDMPs will typically be installed on the ground surface of unimproved areas.
    b. After completion of installation of a DMP, the as-built location in horizontal position shall be determined to an accuracy of ±0.01 foot, and the elevation to accuracy of ±0.01 foot.
2. Installation of Utility Monitoring Points (UMPs):
    a. Utility monitoring points (UMPs) shall be installed at the locations indicated on the approved instrumentation and monitoring plan or as directed by the Engineer.
    b. UMPs shall be installed by excavating to the top of the utility using nondestructive vacuum excavation methods. The Contractor shall be responsible for any utility damage during installation of the UMP.
    c. For each vacuum excavation, provide the following on the UMP installation record:

1) Depth of cover over utility at exploration hole.

2) Outside diameter of utility, when reasonably ascertainable.

3) Utility structure material composition, when reasonably ascertainable.

4) Soil type.

5) Other pertinent information from vacuum excavated hole.

d. Fill annular space with bentonite slurry and install UMP as indicated on the Contract Drawings.

e. After completion of installation of UMPs, the as-built location in horizontal position shall be determined to an accuracy of ±0.01 foot, and the elevation of the top of the UMP to an accuracy of ±0.01 foot.

3. Vibration Monitoring (VMPs):

a. Vibration control and air-overpressure (air blast) monitoring shall be implemented as specified on the approved instrumentation and monitoring plan or as specified in Section 31 70 20 – Controlled Blasting, and as directed by the Engineer. VMPs shall be operational and monitoring/recording throughout the active construction activities inducing vibrations, and throughout the entire duration of all blasting operations.

b. The portable Seismographs shall be used concurrently to monitor vibrations as specified on the approved instrumentation and monitoring plan. Additional locations, identified as TBD in Table 1, shall be proposed/submitted by the Contractor and agreed by the Engineer.

c. Seismograph's vibration sensors and microphones shall be firmly mounted on the concrete surface of slab, asphalt, concrete wall, or firmly set in undisturbed soil.

4. Installation of Crack Monitors (CMs):

a. Crack monitors/meters shall be installed at locations of significant cracks and as determined during the preconstruction inspections and as directed by the Engineer. Crack monitors will typically be installed on horizontal and vertical surfaces of structures. Drilled holes for crack monitors/meters shall be located to avoid significant design features of the structure.

b. Crack monitors/meters shall be installed using either anchors or bolts/screws, epoxy adhesive, a combination of both, or as directed by the Engineer.

c. After completion of installation of crack monitors/meters, the Contractor shall submit to the Engineer a sketch showing the as-built locations in horizontal position and elevation, measured from permanent physical features in the field, with a horizontal and vertical accuracy of 0.1 and 0.04 feet, respectively.

d. Install crack meters as required based on the preconstruction inspections, condition survey specified in Section 31 70 20 – Controlled Blasting and in accordance with the manufacturers recommended procedures.

5. Installation of Groundwater Monitoring Points (GWPs)

a. Vibrating wire piezometers (VWPs) shall be installed at the depths and locations as specified on the approved instrumentation and monitoring plan, or as directed by the Engineer.

b. Using a wash boring or rotary drilling method, install HW or PW flush-joint casing (minimum size) into the subsurface strata. If the material is bedrock, a core sample shall be taken.

c. Install the VWPs from bottom up in the borehole, grout the annular space using cement bentonite grout by tremie pipe. Add weight to each piezometer as required to overcome viscous resistance while lowering VWPs. Withdraw drill casing with the grout without rotation and without withdrawing the grout pipe.

d. Allow grout to set. Verify that VWPs cables are intact.

e. Install protective casing around the cables. Install cement grout in annular space to ground surface as indicated. Identify each instrument with type and number. Connect the VWP cables to data loggers and secure inside the road box.

f. Gaps between roadway box and concrete slab and road box and VWP casing shall be sealed as shown on the drawings.

g. After completion of installation, a post-installation acceptance test shall be performed to verify the VWPs are functioning properly.

h. After completion of installation, the as-built location and elevation of the GWP shall be determined to an accuracy of ±0.01 foot.

3.03 FIELD TESTING / QUALITY CONTROL

A. Field Calibration and Maintenance

1. Prior to their use for collecting Contractor's data, portable Seismographs shall be calibrated by the manufacturer. Subsequently such calibrations shall also be performed at least twice a year. A current certificate of calibration shall be submitted to the Engineer with the data.

2. For inclinometer casings fill with non-toxic anti-freeze with a propylene glycol base. Maintain the concentration of antifreeze, by replacing or adding as necessary, throughout the duration of the Contract.

B. Installation Record:

1. Prepare an installation record as each instrument is installed including appropriate items from the following list:

a. Contract number and title.

b. Instrument type and number, including readout unit.

c. Planned location in plan and elevation.

d. Planned orientation of inclinometer casing.

e. Planned lengths and volumes of backfill.

f. Personnel responsible for installation.

g. Plant and equipment used, including diameter and depth of any drill casing used.

h. Date and time of start and completion.

i. Spaces on record sheet for necessary measurements or readings required during installation to ensure that all previous steps have been followed correctly, including instrument readings made during installation.

j. A log of subsurface data.

k. Type of backfill used.

l. As-built location in plan and elevation.

m. As-built orientation of inclinometer casing.

n. As-built lengths and volumes of backfill.

o. Results of post-installation acceptance test.

p. Weather conditions at the time of installation on record sheet.

q. A space on the record sheet for notes, including problems encountered, delays, unusual features of the installation, and any events that may have a bearing on instrument behavior.

2. Submit a copy of the installation record to the Engineer.

C. Data Collection:

1. The Contractor will collect data, following the guidelines included in the manufacturer's instruction manuals.

2. No instrument will be accepted until initial readings are submitted to the Engineer.

3. The Contractor shall record data on the specially-designed sheets. Field data record shall include at least the following:

a. Project name.

b. Instrument type.

c. Data.

d. Time.

e. Observer.

f. Readout unit number.

g. Instrument number.

h. Readings.

i. Remarks.

j. Visual observation.

k. Other data including:

1) Weather.

2) Temperature.

3) Construction activities.

4. The Contractor shall monitor the instruments within a week after installation to establish base-line readings.

5. An initial DMP and UMP reading shall consist of the average of three readings of the elevation and location of the top of steel rod, using surveying methods. A subsequent reading shall consist of a single reading of the elevation and location.

6. The initial crack monitor reading shall consist of reading of crack monitor and a photograph of the grid reading and the crack at the original location

of the monitor. Subsequent readings shall consist of a single photograph of the grid reading and graph of crack width with time.

7. The Engineer, at their discretion, will make additional independent monitoring measurements using the same readout instruments used by the Contractor. Provide monitoring equipment and access to any instrumentation locations at any time for the Engineer's independent monitoring. Differences between the readings by the Contractor and the Engineer shall be resolved by performing joint readings and data reduction utilizing the manufacturer's instructions. The Contractor, his/her GIE and the Engineer shall jointly participate in readings and data reduction. The Engineer’s readings shall not relieve the Contractor from his regular monitoring as indicated and specified.

8. Geotechnical instrumentation shall be monitored as shown in Table 2 below.

Table 2 – Geotechnical Instrumentation Monitoring Schedule

Geotechnical Instrument	Monitoring Frequency		
	Baseline Readings	Active Construction	Stabilization Period (after Active Construction is Complete)
Deformation Monitoring Points (SDMPs, PDMPs, GDMPs, UMPs)	Monthly	Daily, starting one week prior to the start of the excavation continuing until two weeks after excavation is completed	Monthly until Substantial Completion. Removal of DMPs shall be part of Substantial Completion Punch List
Groundwater Monitoring Points (GMP)	Formal Initial Reading (FIR)	Daily starting one week prior to the start of the excavation activities continuing until two weeks after excavation is completed	Weekly for 3 months after the completion of the Active Construction Period
Vibration Monitoring Points (VMP)	Formal Initial Reading (FIR)	Hourly active construction activities inducing vibrations or more frequent	N/A
Crack Monitors (CM)	Formal Initial Reading (FIR)	Weekly for full duration of Contract	Weekly for full duration of Contract

D. Data Reporting:

1. Real Time Data: The reporting tool shall display aggregate data in real time by default. Real time is defined as time increments of no more than 5 minutes.

2. Archives: All data logged since the beginning of the project shall be available for reporting.

3. Report Types for real-time on demand web-based reporting.

   a. System status: Shows any readings that exceed trigger action values and any system components which are not functioning properly. Alert mechanism shall be programmed into the CDM and reviewed and accepted by the Engineer.

   b. Current readings: Shows the latest reading of all sensors, a group of sensors, or a single sensor and their trigger action levels.

   c. Single device over time: Shows data over time from a single device in the following formats: Line graph and Tabular data.

   d. Like devices over time: Shall show data from two or more like devices over time in the following formats: Line graph and Tabular data.

   e. Unlike devices over time: Generates reports of devices of two different types over a period of time. Reports shall be viewable in either of the following formats: Side by side comparison of single devices of multiple types as line graph and/or tabular data, or side by side comparison of multiple devices of multiple types as line graph and/or tabular data.

   f. Data for any device being polled by a datalogger shall be viewable in the following formats: single device over time, like devices over time, unlike devices over time.

   g. Failure Reporting: Device failure over time: A date/time listing of device failure for specific devices. Report shall include: Device Name, Device Location, Time within 5 minutes of recorded failure.

4. Comments: The system shall also be able to provide on the above reports a summary of the daily and/or instrument specific comments over time.

5. Alert History

   a. Current alert status: A single location within the user interface shall display a notification of the highest current active alert.

b. All alerts shall be logged and available for review when requested via the web interface. Alert history shall be viewable in the following formats:

1) Overall alerts: Summary report of all alerts logged for the Project.

2) By device: Summary of all alerts logged for a particular device.

3) By multiple devices: Summary of all alerts for a user created selection of multiple devices.

4) By frequency: Summary report of alerts sorted by the frequency of the alert type

5) During date/time range: Summary of all alerts for a specified date/time range.

6. Record Reports

a. Produce record reports in PDF format that are locked to prevent alteration.

b. All record reports shall be formatted to a printable version.

c. Data for all record reports shall be shown in appropriate engineering units, with meaningful scales and the appropriate number of significant digits.

d. The following record reports shall be provided to the Engineer by Monday noon via email for all data recorded over the previous week.

1) Tabulation of any readings which exceeded Limiting or Threshold Levels, showing the sensor number together with the reading, the date and time of reading, and any relevant comment on construction activity that may be related to the exceedance.

2) Tabulation of any components of the CDM system that malfunctioned and a brief description of the current component status.

3) Tabulation of any unusual trends in the data for the prior week and any relevant comment on construction activity that may be related to the exceedance.

4) Graphs of historical data for groups of instruments with the groupings to be determined by the Engineer.

5) Any corrections, changes and additions to a previous record report filed.

e. Record reports shall be maintained in an online database organized so that any historical report can be immediately identified and retrieved for the duration of the Project. At completion of the monitoring, an electronic copy of all record reports shall be provided to the Engineer.

7. Seismograph plot requirements are specified in Section 31 70 20 – Controlled Blasting.

E. Protection and Maintenance of Instruments:

1. Install protective barriers to prevent damaging geotechnical instruments in high traffic areas.

2. If any geotechnical instruments are damaged or become inoperative, notify the Engineer within 24 hours from the time that the damage was observed.

3. Provide, maintain and protect the instruments from damage. Damaged and non-functional existing geotechnical instruments indicated on the drawings and specified to be monitored and protected by the Contractor will be evaluated on a case by case basis. Instruments demonstrated to be non-functional will be decommissioned as specified and if deemed necessary, replaced with an appropriate instrument from the list of contingency instruments installed within 3 business days at a location within 50 feet of the original instrument. The Engineer may impose restrictions if a damaged or inoperative instrument is not replaced or made operational in a timely manner.

F. Disclosure of Data:

1. The Contractor shall not disclose any instrumentation data to third parties and shall not publish data without prior written consent of the City.

G. Interpretation of Data and Remedial Action:

1. The Contractor's GIE shall interpret the collected data. Interpretation shall include making correlations between instrumentation data and specific construction activities. Instrumentation data shall be evaluated to determine whether the response to construction activities is reasonable.

2. Table 4 indicates the threshold values for the geotechnical instruments. The actions associated with these threshold values are defined below. Plans for such actions are referred to herein as remedial action. Threshold values are subject to adjustment by the Engineer as indicated by prevailing conditions

or circumstances. Remedial actions shall be submitted and implemented at no additional cost to the City.

3. If a Level 1 limit is reached, the Contractor and his/her GIE shall:
   a. Immediately email notification to individuals listed with the remedial action plan.
   b. Provide phone and email notification to the Engineer within 24 hours.
   c. Meet with the Engineer to discuss the need for remedial action(s).
   d. Engineer may direct the Contractor to suspend construction activities at the location reaching the Level 1 values in Table 3.
   e. If directed by the Engineer, during the meeting, that an additional remedial action is needed, submit a detailed and specific plan of action within 24 hours of the meeting.
   f. If directed by the Engineer, implement remedial action(s) within 24 hours of submitting the plan of action, so that the Level 2 limit is not exceeded.
   g. Monitoring frequency of affected instruments shall be increased to frequency as approved within the remedial action plan.
   h. Install additional instruments if directed by the Engineer.
4. If a Level 2 limit is reached, the Contractor and his/her GIE shall:
   a. Temporarily suspend construction activities related to Level 2 values in Table 3. Construction activities that are required to minimize and limit the monitored values will be continued.
   b. Immediately email notification to individuals listed within the remedial action plan.
   c. Provide phone and email notification to Engineer within 24 hours.
   d. Immediately meet with the Engineer to discuss the need for remedial action(s).
   e. If directed by the Engineer, during the meeting, that an additional remedial action is needed, submit a detailed and specific plan of action within 24 hours of the meeting.
   f. If directed by the Engineer, implement remedial action plan(s) within 24 hours of when Level 2 limit is reached.
   g. If crack monitor readings exceed Level 2 threshold limit and as directed by the Engineer, repair structure (at Contractor's expense)

within 48 hours of the Contractor's receipt of the Engineer's direction.

h. Monitoring frequency of affected instruments shall be increased to frequency as approved within the remedial action plan.

i. Install additional instruments if directed by the Engineer.

Table 3 – Threshold Values for Geotechnical Instruments

Geotechnical Instrument	Level 1	Level 2
UMPs, DMPs	0.75 inch	1.5 inches
VMP - Surface Level Vibration for LEC and UEC	Refer to Section 31 70 20 – Controlled Blasting	
VMP - Vibration Limitations for other structures	Refer to Section 31 70 20 – Controlled Blasting	
Crack Monitors	2 mm	5 mm
GWP	More than 5 ft difference between daily reading	More than 10 ft difference between daily reading

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Disposition of the Instruments:

1. Protect and maintain all instrumentation until such time as written approval authorizing removal of instrumentation has been received from the Engineer.
2. Removal of instruments shall include removing and disposing of protective covers, recovery of salvageable portions of instrumentation and grouting of casings. All salvage materials shall become the property of the Contractor. Make repairs to property damaged by installation or removal of instruments.
3. All readout instruments and portable Seismographs shall be the property of Contractor.
4. Make permanent repairs to roadway and sidewalk paving by replacing materials in kind.
5. Remove and restore surfaces to the original conditions for all decommissioned instruments.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, tools, equipment, materials and incidental items required to perform Site Clearing of all designated areas within the Contract limits and as shown on the Contract Drawings, including work specified in permits and other agreements, in accordance with the requirements of the Contract Documents.

B. The Contractor shall remove all trees within 100 feet of the Contract limits that pose a threat to safety and/or security of the site as determined by the Engineer for the duration of the Contract.

C. The Contractor shall manage and dispose of woody debris potentially infested with harmful agents, including but not limited to Spotted Lanternfly, Dutch elm disease, Emerald Ash Borer and Asian Longhorned Beetle, in accordance with all applicable laws and regulations to prevent the spread of such agents, including 7 CFR 301.51 and NYCRR Title 1 Part 139, as applicable to the location of work. Management of harmful agents may include the performance of site surveys by appropriately qualified professionals and written protocols for the management of any Regulated Articles as directed by the Engineer.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

B. Payment for removal of trees 4 inches or greater in diameter at breast height (DBH) shall be made under individual unit price items as specified in Section 01 27 00 – Measurement and Payment according to the following ranges of DBH:

1. 4” to 6”
2. Over 6” to 12”
3. Over 12” to 18”
4. Over 18” to 24”
5. Over 24”

1.03 RELATED SECTIONS

A. Section 01 14 00 - Work Restrictions
B. Section 01 27 00 - Measurement and Payment
C. Section 01 74 17 - Cleaning and Site Maintenance
D. Section 01 74 20 - Construction Waste Management
E. Section 31 23 16 - Excavation
F. Section 31 23 23 - Fill
G. Section 31 25 10 - Dust, Soil Erosion and Sediment Control
H. Section 32 90 00 - Planting
I. Section 32 90 05 - Soil Mixes

1.04 REFERENCES

A. Definitions

1. Asian Longhorned Beetle (ALB): The insect known as the Asian Longhorned Beetle (*Anoplophora glabripennis*) in any stage of development.
2. ALB Compliance Agreement: A written agreement between United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) and a person engaged in growing, handling, or moving regulated articles that are moved interstate, in which the person agrees to comply with the provisions of 7 CFR 301.51.

3. ALB Regulated Article: The term applies to: (1) Firewood (all hardwood species), and green lumber and other material living, dead, cut or fallen, inclusive of nursery stock, logs, stumps, roots, branches, and debris of half an inch or more in diameter of the following genera: *Acer* (maple), *Aesculus* (horse chestnut), *Albizia* (mimosa), *Betula* (birch), *Cercidiphyllum* (katsura), *Fraxinus* (ash), *Koelreuteria* (golden rain tree), *Platanus* (sycamore), *Populus* (poplar), *Salix* (willow), *Sorbus* (mountain ash), and *Ulmus* (elm); (2) Any other article, product, or means of conveyance not covered in (1) of this definition if a USDA APHIS inspector determines that it presents a risk of spreading Asian Longhorned Beetle and notifies the person in possession of the article, product, or means of conveyance that it is subject to the restrictions of 7 CFR 301.51. This definition is subject to change and should be verified by consulting 7 CFR 301.51 prior to the start of Work.

4. Diameter at Breast Height (DBH): A unit of measurement for the diameter of a tree trunk at a point measured 4½ feet above the ground on the uphill side.

5. Diameter Tape: A special measuring tape used to measure the diameter of a tree.

6. Emerald Ash Borer (EAB): The insect known as the Emerald Ash Borer (*Agrilus planipennis*) in any stage of development.

7. Grubbing: The removal and disposal of all stumps, buried logs, roots and root clusters greater than 1 inch in diameter, matted roots and organic materials.

8. Site Clearing: The removal from the ground surface within the designated areas and disposal of trees, brush, shrubs, fallen trees, decayed wood, wood chips, other vegetation, rubbish, trash, scrap metal, debris and miscellaneous other structures not covered under other Sections as shown on the Contract Drawings, specified or otherwise required to permit completion of the Work.

9. Spotted Lanternfly (SLF): The insect known as spotted lanternfly (*Lycorma delicatula*) in any life stage.

10. SLF Regulated Article: The term applies to: (a) any living life stage of the spotted lanternfly; (b) brush, debris, bark, or yard waste; (c) landscaping, remodeling, or construction waste; (d) logs, stumps, or any tree parts; (e) firewood of any species; (f) packing materials, such as wood crates or boxes; (g) all plants and plant parts including but not limited to nursery stock, green lumber, fruit and produce and other material living, dead, cut, fallen (including stumps), roots, branches, mulch, and composted and uncomposted chips; (h) outdoor household articles, including, but not limited to, recreational vehicles, lawn tractors and mowers, mower decks, grills, grill and furniture covers, tarps, mobile homes, tile, stone, deck

boards, mobile fire pits, and any equipment associated therewith, and trucks or vehicles not stored indoors; and (i) any other article, commodity, item, or product that has or that is reasonably believed to be infested with or harboring spotted lanternfly. This definition is subject to change and should be verified by consulting 1 CRR-NY 142.3 prior to the start of Work.

B. Reference Standards

1. Federal regulations, 7 CFR 301.51 – Asian Longhorned Beetle
2. NYCRR Title 1 Part 139 – Control of the Asian Long Horned Beetle
3. NYCRR Title 1 Part 142 – Exterior Quarantine of Spotted Lanternfly
4. NYCRR Title 6 Part 575 – Prohibited and Regulated Invasive Species
5. Federal regulations, 7 CFR 301.53 – Emerald Ash Borer
6. American National Standards Institute A300 and Z133.1 – Standards for Tree Care and Arboricultural Operations.

1.05 DESCRIPTION

A. Project/Site Conditions

1. Streets, roads, adjacent property and other works and structures shall be protected throughout Work. The Contractor shall return to original condition, satisfactory to the Engineer, facilities damaged by the Contractor's operations.
2. If the site is in an Asian Longhorned Beetle Regulated Area, NYCRR Title 1 Part 139.4 prohibits the movement of Regulated Articles from the regulated area without an ALB Compliance Agreement. A map of known ALB infestations is available online from USDA APHIS.
3. New York State has enacted an external quarantine covering areas of states where SLF is known to have populations. SLF restriction info can be found online from NYS Department of Agriculture and Markets.

1.06 QUALITY ASSURANCE

A. Codes and Standards: State and local laws and code requirements, including those related to noise, shall govern the removal, hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris and other matter.

B. The Contractor or subcontractor responsible for Work affecting ALB Regulated Articles within an ALB quarantine zone shall have an ALB Compliance Agreement.

C. Restrictions on Movement of SLF Regulated Articles

1. SLF Regulated Articles originating from a quarantine area shall not be moved into the project site unless the SLF Regulated Article is accompanied by a certificate of inspection; loaded, handled, or shipped in

a manner reasonably designed to prevent it from becoming infested with or harboring Spotted Lanternfly; and accompanied by a waybill that sets forth its point of origin and intended destination.

2. SLF Regulated Articles that do not originate from a quarantine area but have moved through a quarantine area shall not be moved into the project site unless the SLF Regulated Article is accompanied by a waybill that sets forth its point of origin and intended destination, and is moved directly through the quarantine area without stopping except for refueling and traffic conditions.

D. Site Clearing work shall be conducted in accordance with ANSI A300 and Z133.1.

1.07 SUBMITTALS

A. Tree Removal Plan

1. The Contractor shall submit a Tree Removal Plan to the Engineer for approval. The Plan shall include, at minimum:

a. Drawings showing all trees 4 inches DBH or greater on site, identifying trees proposed for removal, trees to remain, and trees needing protection as described below;

b. A list including genus, species and diameter of all trees 4 inches DBH or greater that will be removed; and

c. A description of:

1) Tree removal schedule in compliance with clearing restriction set forth in Section 01 14 00 - Work Restrictions;

2) The equipment that will be used to perform tree removal;

3) The method for removing woody debris from the Site; and

4) The name and address of all reuse and disposal facilities.

B. Tree Protection Plan

1. The Contractor shall submit a Tree Protection Plan covering all trees 4 inches DBH or greater to remain on-Site or off-Site within 15 feet of the Contract limits to the Engineer for approval by a DEP BWS Forester prior to the start of Site Clearing. The Plan shall include, at minimum:

a. A drawing showing all trees to remain on-Site and locations of all temporary roads, storage, staging, stockpiling and laydown areas;

b. Proposed soil compaction prevention and mitigation measures;

c. Anticipated impact and proposed mitigation measures for any trenching or cut and fill operations; and

d. A description of all measures to be taken to protect the health of trees to remain, including rigid barriers to prevent equipment injury to tree trunks, branches and roots.

C. Certified Arborist

1. All Site Clearing work shall be performed by competent workers only, under the supervision of a Certified Arborist unless otherwise authorized in writing by the Engineer.

2. The Contractor shall submit the name and qualifications of the Certified Arborist to the Engineer for approval. The Certified Arborist shall:

a. Be either an American Society of Consulting Arborists Registered Consulting Arborist or an International Society of Arboriculture Board Certified Master Arborist;

b. Have a minimum of five years of experience working as an arborist; and

c. Have served as the arborist overseeing vegetation removal and protection on at least two previous construction projects of a similar size and scope within the last five years.

D. Asian Longhorned Beetle Management Plan

1. If Site Clearing work will take place within the Asian Longhorned Beetle Quarantine Zone, the Contractor shall submit an ALB Management Plan to the Engineer for approval prior to removal of any trees or vegetation from the Site. The plan shall include the following:

a. Identification of each work site and all transportation routes, haulers, processing and disposal facilities including full contact information;

b. A copy of the Contractor's ALB Compliance Agreement with APHIS;

c. Provisions for notifying the Engineer and APHIS immediately upon the discovery of an ALB infestation. If an ALB infestation is discovered, the Contractor shall stop all Site Clearing work until permission to resume is provided in writing by APHIS. A copy of the permission to resume shall be provided to the Engineer;

d. Schedule for conducting activities involving ALB Regulated Articles; and

e. Method of identification and anticipated quantity of ALB Regulated Articles and proposed handling methods, including storage locations.

2. If ALB Regulated Articles are generated at a site that is not located within an ALB Quarantine Zone, but the materials will be transported into or

through a quarantine zone for processing or disposal, the plan shall include:

a. Identification of each work site and all transportation routes, haulers, processing and disposal facilities including full contact information;

b. A copy of the Contractor's ALB Compliance Agreement with APHIS;

c. A copy of the processing or disposal facility's ALB Compliance Agreement with APHIS; and

d. For Intrastate Movement - Identification of the origin and destination of the regulated article in accordance with NYCRR Title 1 Part 139.

E. Other Pest Management Plans

1. Management plans for other insect pests as required by regulation and the Engineer at the time of Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. The Contractor shall guarantee that Work performed under this Section shall not damage vegetation designated to remain. If damage resulting from Contractor's operations appears during the period up to 12 months after Substantial Completion, the Contractor shall repair or replace damaged items as directed by the Engineer and at no additional cost to the City to the satisfaction of the DEP.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Tree Protection Barriers

1. Barriers shall be made of 3/8-inch-thick plywood or other rigid material acceptable to DEP.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Site Inspection

1. After all relevant submittals have been approved, and at least 15 business days prior to start of Site Clearing, the Contractor shall arrange and hold a site inspection with the Certified Arborist, the Engineer, a DEP BWS Forester, a DEP BWS Wildlife Studies representative, the Site Clearing subcontractor, if any, and any other representatives required by the Engineer or DEP to discuss specific details of execution. Prior to the site inspection, the Contractor shall survey and stake the limits of disturbance and identify with paint or flagging tape all trees greater than 4 inches DBH to be removed. Disturbance limits shall not be flagged as an alternative to staking. The parties will review the requirements of the Contract Documents, all required submittals, the exact trees to be removed and protected, the equipment to be used, reuse and disposal methods, and any other pertinent issues.

B. The Contractor shall measure the diameter of each tree with a diameter tape at DBH prior to removal to determine payment size category.

C. No plants shall be removed and stored for replanting at completion of Work unless species identified as threatened or endangered by New York State or the United States Fish and Wildlife Service are encountered and reuse is required by regulating agencies.

D. Air pollution caused by dust and dirt shall be controlled, complying with governing regulations. Dust control shall be as specified in Section 31 25 10 – Dust, Soil Erosion and Sediment Control.

E. The Contractor shall strip and stockpile existing topsoil as described in Section 31 23 16 – Excavation. Heavy growths of grass shall be removed from areas before stripping the topsoil.

3.02 IMPLEMENTATION

A. Site Clearing

1. The Contractor shall clear all specified items as shown on the Contract Drawings.

2. Tree Clearing Schedule Restrictions

a. Due to on-site habitat for endangered bat species, tree removal shall only occur between November 1 and March 31 per section 01 14 00 – Work Restrictions, 1.05.K.2.

b. Site Clearing shall comply with all approved plans, including but not limited to the Tree Removal Plan, Tree Protection Plan, and ALB Management Plan.

3. Only those trees designated on the Contract Drawings for removal shall be removed.

4. The Contractor shall protect from defacement, injury and destruction all trees and shrubs within or adjacent to the Contract limits identified to remain in the Contract Drawings or by the Engineer as per the approved Tree Protection Plan. Trees, shrubs, and grassed areas which are to remain shall be protected with fences, barriers, or other methods as shown on the Contract Drawings, specified, or approved by the Engineer. Tree wrap shall not be used as a protection method.

   a. Tree Protection Barriers

      1) Barriers shall be installed around all trees to remain, including those adjacent to temporary roads, storage, staging, stockpiling and lay down areas.

      2) Barriers shall be placed on the operational side(s) of trees to remain, and trees shall be centered behind them. Barriers shall be located as far from trees as possible, but in no case shall be located less than 4 feet away from the trunks of trees to remain.

      3) Barriers shall be at least 4 feet tall and 4 feet wide, or wide enough to completely shield the area to be protected from equipment entry.

      4) Barriers shall be adequately framed and anchored to the ground to withstand impacts from equipment.

      5) Orange construction fencing shall not be used as a barrier unless otherwise approved by the Engineer.

      6) Barriers shall be inspected on a regular basis and repaired as necessary for the duration of the Work.

      7) At the completion of the Work the Contractor shall remove Tree Protection Barriers in the Relocated Westlake Drive area and other areas as directed by the Engineer.

   b. No parking of vehicles or equipment or stockpiling of materials of any kind shall occur within the dripline of trees to remain to avoid root damage and minimize soil compaction. This provision shall apply to all areas on- or off-Site.

c. Wheeled and/or tracked equipment and vehicles shall not be operated within the dripline of trees to remain.

d. Excavated materials shall not be placed or piled within the dripline or adjacent to trunks of trees to remain.

5. Within the area from the tree trunk up to 4 feet outside of the tree dripline, any unavoidable excavation work shall be performed with extreme care using either hand tools or equipment that will not cause damage to tree roots.

   a. Roots shall not be disturbed or cut unnecessarily. Roots 2 inches and larger shall not be cut unless approved by the Engineer and DEP.

   b. Exposed roots shall be immediately covered with well-watered burlap made of jute with a weight not less than 7.2 ounces per square yard. The Contractor shall keep the burlap damp at all times until backfilling is complete to prevent desiccation.

   c. The Contractor shall immediately backfill around tree roots after completion of construction in the vicinity of trees.

   d. Vegetation shall be protected from damage caused by equipment emissions.

   e. Runoff shall not be allowed to accumulate around trees to remain.

   f. Ropes, cables, and guy wires shall not be fastened or attached to trees to remain.

   g. The Contractor shall not trim trees and shrubs to remain unless otherwise directed by the Engineer. Axes and climbing spikes shall not be used during tree trimming.

   h. Any trees to remain that are irreparably damaged during construction, as determined by the Engineer and DEP, shall be removed at the Contractor's sole expense. The Contractor shall provide restitution for irreparably damaged trees according to the Council of Tree and Landscape Appraisers Trunk Formula Method as determined by a DEP BWS Forester and the Engineer. Restitution shall consist of the Contractor planting the required equivalent number of replacement trees at locations determined by the Engineer at no additional cost to the City.

6. When directed by the Engineer, emergency repair to damaged trees and to trees which pose an imminent danger shall be performed within 24 hours.

7. Choose an item.All bar and chain oil used for Site Clearing shall be biodegradable.

8. In areas that are cleared but not grubbed, if any, the Contractor shall cut stumps as close to the ground surface as practicable. In no case shall any

stump be left higher than the root swell or one half its diameter, whichever is lower.

9. If the Contractor encounters mammal dens or active bird nests during Site Clearing, Contractor shall take steps not to disturb said den or nest and shall contact DEP BWS Wildlife Studies and the Engineer for further instruction. Site Clearing work may continue outside of a 75-foot buffer around the den or nest.

10. If the Contractor encounters any threatened or endangered species during Site Clearing, Site Clearing work shall be immediately suspended and DEP BWS Wildlife Studies and the Engineer shall be contacted for further instruction. Site Clearing work shall not resume until authorized by DEP BWS Wildlife Studies.

B. Grubbing

1. The Contractor shall grub all specified items to a depth not less than one (1) foot below the ground surface in all areas shown in the Contract Documents to be excavated and/or graded, unless otherwise directed by the Engineer. In areas where structures will be built, underground utilities will be installed, or roadways will be constructed, grubbing shall occur to a depth of not less than three (3) feet below the ground surface.

2. At the discretion of the Engineer, in areas receiving more than 3 feet of fill, grubbing may be limited to large stumps or groups of stumps.

3. Trees shall be cut at the stump and felled prior to grubbing.

4. Earthwork operations shall not occur in areas where Site Clearing is not complete, except that stumps and large roots may be removed concurrent with excavation.

5. Grubbing shall occur during dry soil conditions only to minimize the potential for erosion, unless otherwise authorized by the Engineer. Grubbing operations shall be suspended during heavy rainfall or saturated soil conditions.

6. The Contractor shall comply with erosion, sediment control and storm management measures as specified in Section 31 25 10 - Dust, Soil Erosion and Sediment Control.

7. Explosives shall not be used for grubbing.

8. All depressions made by the removal of stumps or roots shall be filled to grade with material suitable for backfill as specified in Section 31 23 23 - Fill.

9. Invasive species shall be controlled in accordance with Section 01 74 17 – Cleaning and Site Maintenance.

C. Disposal

1. The Contractor shall remove from Site and beneficially reuse or recycle all cleared and grubbed material, including wood chips, unless otherwise authorized by the Engineer. The Contractor shall identify at least three recycling/reuse facilities in the Construction Waste Management Plan as per Section 01 74 20 – Construction Waste Management.

2. The Contractor may use chipped wood from removed trees on-Site for winter stabilization of disturbed areas. Due to impacts to nitrogen cycling, no more than 1 acre shall be stabilized with fresh wood chips. Wood chips from invasive species shall not be used. Wood chips shall be no deeper than 3 inches. Fresh wood chips shall not be used in landscaping work. The Contractor shall perform all required mulch stockpile maintenance to prevent excessive heat or nuisance odors. See Section 31 25 10 – Dust, Soil Erosion and Sediment Control.

3. Cleared and grubbed material shall not be disposed of in wetlands, watercourses, or waterbodies.

4. All disposal shall be in complete accordance with rules and regulations of all authorities having jurisdiction and of the requirements of this Contract.

5. No material shall be burned within the property limits.

6. No material shall be used in backfills or embankments.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04

3.05 STARTUP / DEMONSTRATION

A. Not Used

3.06 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes excavation work and reuse or disposal of all material as specified herein, shown on the Contract Drawings or required by the Engineer, for any purpose pertinent to the construction of the Work.

B. Excavation Work includes stripping and stockpiling of topsoil; sheeting and bracing; excavation over the site; excavation for roads, pipelines and structures; removal and control of water in and around excavations; segregation and stockpiling of excavated material; disposal of unsuitable material and excess excavated material; reuse of suitable material; and trimming, shaping and grading of excavations.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 35 45 - Hazardous Materials Control

B. Section 02 24 20 - Soil Sampling and Analysis

C. Section 05 12 00 - Structural Steel Framing

D. Section 31 10 10 - Site Clearing

E. Section 31 23 25 - Rock Excavation

F. Section 31 23 19 - Dewatering

G. Section 31 23 23 - Fill

H. Section 31 25 10 - Dust, Soil Erosion and Sediment Control

I. Section 32 31 15 - Chain Link Fence

J. Section 32 90 05 - Soil Mixes

1.04 REFERENCES

A. Definitions:

1. Case-Specific Beneficial Use Determination (BUD): Under 6 NYCRR Part 360, Section 360.12(d), NYSDEC sets forth the requirements for petitioning NYSDEC to obtain a Case-Specific BUD, and the criteria for reviewing, granting, or denying of the BUD. For reuse of a solid waste to be determined a beneficial use, the petition must satisfy all criteria outlined under 6 NYCRR Part 360, Section 360.12(d).

2. Excavated Material: All material regardless of its nature, except rock or boulders that have been excavated. The requirements for excavation of rock and boulders are set forth in Section 31 23 25 - Rock Excavation.

3. Rock: All materials requiring barring or wedging for their removal from their original beds and specifically includes all ledge or bed rock and boulders or masonry larger than one-half cubic yard in volume, but excludes pavements and pavement foundations.

4. Fill: Soil and similar material excavated or brought to the project site for the purposes of construction. All fill material must meet the requirements of Section 31 23 23 – Fill. Material to be excavated and proposed for reuse as Fill under Pre-Determined Beneficial Use must meet the requirements of 6 NYCRR Part 360, Section 360.13 (a), Applicability, Section 360.13 (b), Waste Cessation, or Section 360.13 (c), Exemption for On-site Reuse of Fill Material. If these criteria cannot be met, such material shall meet Section 360.12(d), Case-specific beneficial use determinations - general. Fill from an off-site source shall be non-hazardous and uncontaminated.

5. Pre-Determined Beneficial Use for fill material: Under 6 NYCRR Part 360, Section 360.13(b) Waste cessation. "Fill material ceases to be solid waste in accordance with the following:

   a. Restricted–use fill and limited-use fill – once delivered to the site of reuse;

   b. General fill generated outside of the City of New York – once a determination that it is general fill has been made;

   c. General fill generated within the City of New York – once delivered to the site of reuse."

   d. Under 6 NYCRR Part 360, Section 360.13 (c), Exemption for on-site reuse of fill material. "Fill material used as backfill for the excavation from which the fill material was taken, or as fill in areas of similar physical characteristics on the project property is exempt from regulation" under 6 NYCRR Part 360. "If fill material exhibits historical or visual evidence of contamination (including odors), and will be used in an area with public access, the relocated fill material must be covered with a minimum of 12 inches of soil or fill material that meets the criteria for general fill, as defined in" Section 360.13, Special requirements for pre-determined beneficial use of fill material. Refer to Section 02 24 20 - Soil Sampling and Analysis for sampling requirements, including a list of parameters to be analyzed for soils to be reused on-site, or soils to be reused or disposed off-site.

6. Suitable Material: Any material whose composition is satisfactory for use as Fill. Any mineral (inorganic) soil, blasted or broken rock and similar materials of natural or man-made (i.e. recycled) origin, including mixtures thereof, are considered suitable materials. Determinations of whether a specific natural material is suitable shall be made by the Engineer on the above basis.

7. Topsoil: Topsoil shall consist of natural loam, free from subsoil, obtained from an area which has never been stripped. Topsoil is friable clay loam surface soil found in a depth of not less than 4 inches, and is substantially free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material. Topsoil shall be as further defined under Section 32 90 05 – Soil Mixes. Topsoil meeting this definition and Section 32 90 05 – Soil Mixes shall be considered suitable for use on-site.

8. Unsuitable Materials: Any material containing vegetable or organic matter such as muck, peat, organic silt, topsoil or sod, that is not satisfactory for the use as Fill material. Certain man-made deposits of industrial waste, or contaminated materials may also be determined to be unsuitable materials.

B. Reference Standards:

1. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)
2. Occupational Safety and Health Administration (OSHA); OSHA 1926 Subpart P-Excavations
3. U.S. Department of Labor (DOL)
4. Industrial Board of Appeals, N.Y.S. Department of Labor, Part 23 Protection in Construction, Demolition and Excavation Operations latest editions
5. New York State Department of Transportation (NYSDOT)
6. New York State Department of Environmental Conservation (NYSDEC)
7. U.S. Department of Transportation, Federal Highway Administration
8. U.S. Environmental Protection Agency (EPA)
9. NYSDEC regulations, 6 NYCRR Part 375, Environmental Remediation Programs
10. NYSDEC regulations, 6 NYCRR Part 360, Solid Waste Management Facilities General Requirements
11. New York State Building Code

1.05 DESCRIPTION

A. Design Requirements:

1. In designing the sheeting, take note of the minimum load diagram requirements of the DEP, shown in Attachments A and B at the end of this Section, unless otherwise shown on the Contract Drawings. However, when it is anticipated that heavier crane or equipment loads will fall within the influence line of the excavation, increase design loads accordingly.
2. The Contractor's operations shall conform to the requirements of Section 31 25 10 - Dust, Soil Erosion and Sediment Control.
3. Site Conditions:
   a. Actual Conditions: Perform any geotechnical investigations deemed necessary to determine actual site conditions. Geotechnical data reports, if they are available, will be provided in the Contract Documents.
   b. Underground Utilities: Locate and identify all existing underground utilities prior to the commencement of work.

B. Regulatory Requirements:

1. General: Before proceeding with any excavation, obtain all necessary permits required by agencies having jurisdiction and consents from owners of private property where their interests may be affected by the Work, such

as for temporary or permanent occupation, for disposal or storage of materials, or other encroachment except where temporary easements may have been obtained by the City in connection with permanent easements or otherwise.

2. Excavation operations and related work shall be performed in strict compliance with the applicable sections of OSHA 1926 Subpart P-Excavations, New York City Department of Buildings Regulations and N.Y.S. Department of Labor, Industrial Board of Appeals, Part 23 Protection in Construction, Demolition and Excavation Operations latest editions.

3. In the period of 2 to 10 days prior to starting excavation, notify all utilities of intended work locations and have utility locations marked. In NYC locations, the New York City Long Island One Call Center (800-272-4480) is available for this use. Upstate locations are served by Dig Safely NY (800 962-7962 or 811).

4. Recycled materials that the Engineer has evaluated and approved for general use shall be considered to be Suitable Material subject to the conditions for use as determined by the City. In general, the use of recycled materials must be sanctioned by NYSDEC, usually in the form of a BUD. See definition above.

C. Excess soils or Rock not reused onsite shall be reused offsite to the extent possible in the following hierarchal locations:

1. Other DEP projects that need available, excess suitable materials;

2. New York State beneficial use facilities;

3. Or outside of New York State at other applicable out-of-state agency beneficial use facilities.

1.06 QUALITY ASSURANCE

A. Certification of Laboratory Services:

1. For certification of Laboratory Services see Section 02 24 20 - Soil Sampling and Analysis.

1.07 SUBMITTALS

A. Sheeting and Bracing: Before commencing any excavating operations, submit for approval Shop Drawings of all sheeting and bracing, cofferdams, bridging, decking, soldier beams and lagging, and other temporary or permanent supporting structures.

1. Shop Drawings shall show types of materials, dimensions and details of the entire bracing system, including wale splices and corner connections, stressing/jacking methods, reaction systems, posting and rebracing, if necessary.

2. Provide plans, details and procedures for jacking-in preload at struts.

3. For sheeting and shoring not shown on the Contract Drawings submit engineering calculations and design assumptions for determination of loads and stresses acting in the wall and lateral supports during installation, as well as final conditions. Show locations at which the temporary or permanent supporting structures will be used. The proposed design shall take into account the excavation procedures, dewatering operations, surcharge loading, soil properties, material stresses, temperatures, permanent construction, stages of work and all other conditions which could affect the excavation support system and the permanent structure. These drawings and calculations shall be prepared and stamped by a Professional Engineer licensed in the State of New York.

B. Soil and Rock Excavation, Reuse, Transport and Disposal Plan (SERTD Plan): Submit a SERTD Plan to the Engineer for approval at least 30 calendar days prior to the start of excavation. The SERTD Plan shall include two protocols: the Excavation Protocol and the Reuse, Transport and Disposal Protocol.

1. The Excavation Protocol shall include, but not be limited to, the following:

   a. Limits of excavation

   b. Excavation methods

   c. Protection methods:

      1) Sheeting and bracing

      2) Fencing, bridging and decking

2. The Reuse, Transport and Disposal Protocol shall address the following waste classifications defined in Section 02 24 20 – Soil Sampling and Analysis: hazardous solid waste; non-hazardous contaminated waste; non-hazardous petroleum-contaminated waste; non-regulated solid waste, and construction and demolition (C&D) debris. The Protocol shall include the following:

   a. Details on proposed reuse:

      1) Identities of beneficial use facility (ies) with copy (ies) of their regulatory approvals, as applicable. Unless otherwise reused under Pre-Determined Beneficial Use, details shall include all supporting back-up information sent to and received from NYSDEC or other applicable out-of-state agency. See Section 02 24 20 - Soil Sampling and Analysis for on-site reuse criteria. When reusing soils on site, details of temporary (stockpile) storage and the location(s) of reuse shall be identified.

      2) As applicable, the requirements of each beneficial use facility / treatment, storage, and disposal facility (TSDF) for sampling, including analytical parameters, frequencies, protocols, and minimum detection limits.

b. Transportation details:

1) Identities of waste transporters; supporting NYSDEC Part 364 Waste Transporter Permit(s) and other out-of-state transporter permits required to transport the wastes to the TSDFs; or for use of public roadways if temporary off-site storage becomes necessary.

c. Disposal details:

1) Identities of TSDFs solicited including names and locations, insurance certificate, permit documentation including the types of materials allowed and not allowed, and chemical and physical material acceptance criteria. If no concentrations are indicated, then the facility must indicate the types of material that it is allowed to accept under its permit. Treatment, storage, or disposal of any waste generated by excavation work shall be at a facility permitted to accept such waste by an authorized state or local government agency, or the EPA, as applicable.

3. The SERTD Plan shall be coordinated with the Field Sampling Plan (FSP), including beneficial use facilities/TSDF selection, and associated materials acceptance requirements specified in Section 02 24 20 – Soil Sampling and Analysis, as applicable.

4. The SERTD Plan shall be prepared in accordance with all applicable Federal, State and local hauling and disposal codes and regulations

5. Reuse of Excavated Material or Rock either on-site or off-site must be prioritized over disposal. TSDFs shall only be approved where reuse options are not available.

6. Under separate cover, additional waste disposal documentation submittals for DEP signature as generator. The Contractor shall provide waste profiles, facility letters of acceptance of DEP waste, advance copies of waste manifest(s), and Land Disposal Restriction (LDR) Notification and Certification Form (if hazardous waste) for the Engineer's review and approval and DEP signature as generator, where applicable.

C. Manifest Requirements and Submittals: Manifests shall include measurements of the volume of all Excavated Material or Rock to be removed from the site prior to transporting to an approved beneficial use facility/ TSDF. The Contractor shall also prepare all vehicles and manifests necessary for transporting all material. The Contractor shall comply with all Federal, State and local regulations regarding the transport of hazardous and non-hazardous waste.

1. Applicable Regulations: All Contract Work that concerns the transport of hazardous and non-hazardous waste shall comply with the appropriate EPA and NYSDEC regulations, and DOT hazardous material transportation regulations.

2. EPA Hazardous Waste Manifest: The Contractor shall obtain an appropriate number of hazardous waste manifest forms (EPA Form 8700-22 (Rev. 3-05) or latest version), sequentially numbered for this Contract based on the quantity of hazardous waste to be removed from site. The name of the generator, transporter and TSDF, and their appropriate EPA identification number, shall be typed on each form. All other pertinent information shall be included on the manifest. A copy of the partially completed manifest including the above information shall be submitted for approval at least 3 weeks prior to commencement of excavation.

    a. Routing: The Contractor shall provide a map and written description of the route which will be taken to the approved TSDF by the hazardous waste transporter.

3. Non-hazardous Waste Manifest: Manifests shall be provided for each truckload of non-hazardous waste removed from the site, including soils destined for reuse. The form of the manifest shall be approved by the Engineer. Non-hazardous waste shall be transported in accordance with all applicable local, State and Federal DOT regulations by properly licensed and permitted waste haulers.

    a. Routing: The Contractor shall provide a map and written description of the route which will be taken to the approved beneficial use facility / TSDF by the non-hazardous waste transporter.

4. The Contractor shall submit written evidence that selected beneficial use facilities / TSDFs have accepted or will accept the materials generated during excavation. The Contractor shall also submit copies of the completed manifest, signed and dated by the initial transporter, in accordance with Federal and State requirements and with associated documentation (e.g., waste profile and Hazardous Waste LDR Notification and Certification Form, as applicable). Copies of completed and signed waste manifests from beneficial use facilities / TSDFs shall be provided to the Engineer within 30 days of waste shipment off-site.

5. Bill of Lading: Bills of Lading shall be provided for all uncontaminated soils or Rock destined for reuse off-site. Uncontaminated soil shall be removed by a properly licensed hauler.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Steel for struts, braces, and whalers shall meet the requirements of Section 05 12 00 – Structural Steel and the Contract Drawings.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. General: No excavation Work below the water table shall begin before the Dewatering Plan is approved, as specified in Section 31 23 19 - Dewatering.

B. Clearing and Grubbing: Clear and grub the site of all open cut excavations and all areas shown on the Contract Drawings and specified. The Contractor shall comply with the requirements of Section 31 10 10 - Site Clearing.

C. Stripping: Strip the top 12” of Topsoil and earth containing roots away from areas which have been cleared and grubbed.

1. Topsoil stripped from the RWLD area shall be stockpiled within the RWLD disturbance areas and used for final RWLD landscaping.

2. Topsoil stripped from areas outside of RWLD construction shall be stockpiled in the Delaware aerator topsoil pile indicated in the contract drawings. Topsoil pile shall be stabilized with a seed mix in accordance to section 32 90 00 – Planting and section 31 25 00 – Dust, Soil Erosion and Sediment Control. Topsoil pile shall be placed and compacted in accordance with common fill requirements in section 31 23 23 – Fill.

3. Topsoil to be reused on-site shall be amended as required to comply with the requirements of Section 32 90 00 – Soil Mixes. Topsoil to be reused on-site or off-site may require testing to meet the requirements for NYSDEC Pre-Determined Beneficial Use or a Case-Specific BUD per 6 NYCRR Part 360, or other applicable out-of-state agency’s requirements for a Case-Specific BUD.

4. For further discussion on Topsoil reuse refer to Section 02 24 20 – Soil Sampling and Analysis and Section 31 23 23 – Fill.

D. Sheeting and Bracing:

1. The Contractor shall provide all labor, equipment, materials and incidental items and services necessary to perform sheeting and bracing as indicated on the Contract Drawings and specified herein. Sheeting and bracing shall include but not limited to:
   a. Furnish, install, preload and maintain a system of wales, struts, kickers and bracing appurtenances to shore portions of the earth support walls as shown on the Contract Drawings.
   b. After support is provided, including installation of base slabs, unload and remove wales, struts, kickers and bracing as required.
   c. The arrangement, construction, testing and maintenance of the lateral bracing system shall be the responsibility of the Contractor.
2. All excavations shall be excavated with vertical sides and properly sheeted and braced for the full depth of the excavations, unless otherwise shown on the Contract Drawings, specified or ordered in writing by the Engineer. All excavation shall be shored and braced in accordance with 29 CFR 1926 Subsection P requirements and New York City Department of Buildings regulations
3. Pilot cuts for excavations shall not exceed 5 feet in depth and shall be made with equipment approved by the Engineer. The equipment to be used and the method to be employed in starting the sheeting operation shall be submitted for approval and must be approved in writing by the Engineer before the start of work.
4. Exception: Excavation for structures or pipelines 5 feet in depth or less need not be sheeted and braced except where excavation is in close proximity to existing footings or conduits and where unsupported sides may be unstable.
5. Design and install sheeting and bracing in excavations for pipelines so that at no time shall sheeting be braced or blocked against the sides of pipe or conduit. Do not drive sheeting for pipelines below the elevation of the bottom of the pipe. If it is necessary to drive the sheeting below that elevation in order to obtain a dry trench or satisfactory working conditions, cut off the sheeting and leave in place below the top of the pipe at no additional cost to the City.
   a. Contractor shall design and provide additional and supplemental sheeting and bracing as needed to perform the excavation.
   b. Adjust field locations of wales, rakers, struts and braces as required and approved by the Engineer to avoid interference with new work and provide sufficient bearing. Block between wales and sheets with steel shims immediately after installing braces.
   c. Struts shall be wedged, posted and tied to form a stiff support. Rakers and struts to be preloaded shall be jacked to the loads shown

on the Contract Drawings. Rakers and struts shall be preloaded in the presence of the Engineer.

d. Provide web stiffeners, plates or angles as needed to prevent rotation, crimping or buckling of connections and points of bearing between structural steel members and/or jacks occasioned by eccentricities caused by field fabrication, assembly or conditions.

e. Protect bracing members from damage by construction equipment and other causes. Repair any damage promptly and erect temporary barriers to secure area of damage, as required.

6. Where permitted or ordered in writing by the Engineer, slope the sides of the excavation to elevations approved by the Engineer and excavate below such elevations with vertical sides, properly sheeted and braced. Side slopes must be stable. Banks more than 5 feet high shall be shored and sloped to the angle of repose in accordance with current OSHA standards to furnish safe working conditions, to prevent shifting of material, to prevent damage to structures or other work and to avoid delay to the work, all in compliance with U.S. Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety and Health Act of 1970 and under Contract Work Hours and Safety Standards Act, as amended. The minimum shoring, sheeting and bracing for trench excavations shall meet the general trenching requirements of the applicable safety and health regulations. However, in no case shall the sides of trench excavations for pipe or conduit be sloped to elevations lower than 2 feet above the top of the pipe or conduit.

7. Removal of sheeting:

a. When the sheeting and bracing for the vertical sides of such trench excavations is not required to be left in place, such sheeting and bracing shall be removed, and backfill shall be placed and compacted to an elevation at least 1'-6" above the top of the pipe or conduit. This requirement shall be met unless an exception is provided elsewhere in the Contract Documents.

b. Where sheeting and bracing is removed, it shall be done as the excavation is refilled in a manner to avoid the caving in of the bank or disturbance to adjacent areas or structures, except as otherwise shown on the Contract Drawings or directed. Carefully fill voids left by the withdrawal of the sheeting by ramming or otherwise as directed by the Engineer.

c. Obtain permission of the Engineer before the removal of any shoring, sheeting or bracing. Such permission by the Engineer shall not relieve the Contractor of responsibility for injury to structures or to other property or persons resulting from failure to leave such sheeting and bracing in place.

d. Load from rakers, struts and corner braces shall be released in a controlled fashion by cutting kickers and removing wedges and shims, as approved by the Engineer.

8. Credit: Sheeting and bracing required to be provided by the Contract Drawings or the Sections and subsequently allowed or ordered in writing by the Engineer to be omitted shall be subject to suitable credit to the City. Measurement of sheeting and bracing limits subject to suitable credit shall extend from the subgrade to within 18 inches of the ground surface in the case of vertical sides, regardless of stages; and shall extend from the subgrade to 12 inches above the junction of the vertical and sloping sides in the case of excavations with sloped sides above and vertical sides below. Sheeting and bracing indicated to be omitted on the Contract Drawings will not be subject to credit.

9. Width: The width of trenches, between inner faces of sheeting or rock, as the case may be, shall not exceed the width of the structure to be installed by more than 3 feet. Where two or more stages of sheeting are used, the width of trench shall not exceed the width of structure by 3 feet at the lowest stage of sheeting to a point 2 feet above the top of pipe or conduit.

10. In cases where sheeting and bracing will not adequately protect adjacent structures from damage and settlement, the Contractor shall employ other methods, such as underpinning. The Contractor shall hold the City harmless from all claims for damage arising from failure to adequately protect all structures. The Contractor will be presumed to have fully examined and inspected the buildings before estimating the costs and hazards involved.

11. If, in the opinion of the Engineer, any of the approved temporary or permanent supporting structures are inadequate or unsuitable for the actual conditions in the field, the Engineer may direct the Contractor to strengthen the supporting structures at no additional cost to the City. The Contractor shall be responsible for the sufficiency of all temporary and permanent supporting structures whether or not directed by the Engineer to strengthen them.

E. Protection of Plants and Structures: Before starting excavation, clear away all obstructions which are to be removed or relocated. Properly brace and protect trees, shrubs, poles and other structures which are to be preserved. Comply with the requirements of Section 31 10 10 - Site Clearing.

F. Frost Prevention: Protection shall be provided against the penetration of frost into material below the bearing level during work in the winter months. This protection shall consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other approved means

G. Removal of Water:

1. Conform to the requirements of Sections 31 23 19 - Dewatering and 31 25 10 - Dust, Soil Erosion and Sediment Control.

2. Care of Water: At all times during the Work, including final inspection, provide and maintain ample means and suitable equipment with which to promptly remove and properly dispose of all water entering excavations or other parts of the Work. Keep all excavations dry at all times until the structures to be built therein are completed and backfilled to approximately final grades except where otherwise approved by the Engineer in writing. Do not permit sewage from existing sewers and house connections to flow into excavations.

3. To prevent flotation or uplift of the structure or portions of the structure under construction, provide approved dewatering or freezing methods which shall operate under supervision 24 hours per day, including holidays and weekends. Maintain this dewatering or other system in continuous operation until the structure or portions of the structure are substantially completed to a gravity load 10 percent greater than the upward load caused by the ground water uplift pressure measured and computed from the original ground water level. Place backfill and mechanically compact it to approximately final grade after the structure has achieved the required strength, except where otherwise approved by the Engineer in writing. In addition, provide and have available at the work site suitable standby equipment for prompt replacement during breakdowns of operating equipment.

4. The dewatering system shall be maintained in operation as required in Section 31 23 19 – Dewatering.

5. Obtain written approval from the Engineer before discontinuing the dewatering or other groundwater control system.

6. Where water or sewage has accumulated or is flowing in the completed or partly completed structures, remove and dispose of such water or sewage during the time covered by the Contract, unless otherwise directed by the Engineer.

7. The Contractor shall take care of all sewer drainage interfered with by his operations to the satisfaction of the Engineer. Drainage into trench excavations is expressly prohibited.

3.02 IMPLEMENTATION

A. Structure Excavation:

1. Excavations shall be of sufficient size to permit the Work to be safely and properly constructed in the manner and of the size specified, except where limits of excavation are provided on the Contract Drawings. The bottom of the excavation in earth and rock shall have the shape and dimensions of the underside of the structure with allowance for the concrete work mat or compacted aggregate base layer.

2. Exercise care to prevent disturbing or loosening of the soil in the excavation. Densify the bearing surface for all structures with an approved type

vibratory compactor to 95 percent of the maximum dry density obtainable by ASTM D1557 before the construction of any foundations. Where the depth of disturbed or loosened soils is greater than 12 inches or; as determined by the Engineer, that it will require special compaction; the Contractor shall propose the appropriate method of compaction and submit to the Engineer for approval. All disturbed or loosened soils as determined by the Engineer that should be removed shall be replaced in accordance with the requirements of Paragraph 3.03D "Unauthorized Excavation".

3. Whenever abandoned existing piles are encountered during excavation, they shall be cut off at least 18 inches below the bottom of new footings, unless otherwise indicated on the Contract Drawings, and shall not be pulled.

B. Site Excavation:

1. Excavate over the site within the limits of site grading to conform to finished site grades. Arrange the excavation work to permit continuous surface drainage off the site, eliminate low spots and surface ponding, and prevent runoff from flowing into the surrounding areas.

C. Trench Excavation:

1. Maintain the minimum trench width adequate to place, joint and backfill the pipe or conduit properly. The clear width of the trench at the level of the top of the pipe shall not exceed the sum of the outside diameter of the pipe barrel plus 20 inches for pipe 4 through 24 inches in diameter nor the outside diameter of the pipe barrel plus 2 feet for pipe more than 24 inches in diameter, unless otherwise approved by the Engineer. The banks of pipe trenches shall be as near to vertical as practicable.

2. Length of Excavation: Make excavation for the sewers, drains, ducts, conduits or pipelines only a reasonable distance in advance of pipe laying, at the discretion of the Engineer, and as may be indicated by the supply of materials on hand.

3. In sheeted trenches, measure the clear width of the trench at the level of the top of the pipe to the inside of the sheeting.

   a. Pipes placed in trenches wider than specified above shall be provided with concrete cradle or encasement as directed by the Engineer. No separate payment will be made for such cradles or encasement.

   b. Do not overexcavate the bottom of the trenches. The bottom of trenches shall be graded accurately to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length (except for the portions of the pipe sections where it is necessary to excavate for bell hole, for the proper sealing of pipe joints, and as hereinafter specified).

c. Dig bell holes and depressions for joints after the trench bottom has been graded. In order that the pipe rests on the prepared bottom for as nearly its full length as practicable, make bell holes and depressions only of such length, depth, and width as required for properly making the particular type of joint. Remove stones as necessary to avoid point bearing. Except as hereinafter specified for wet or otherwise unstable material, backfill overdepths with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, over excavate such material (a minimum of 2 feet below pipe) to a depth to allow for construction of stable pipe bedding. Backfill the trench to the proper grade with suitable approved materials as per Section 31 23 23 - Fill.

d. If unstable material is exposed at the level of the bottom of the trench excavation, it shall be excavated in accordance with Paragraph 3.03C "Authorized Additional Excavation". When the Engineer judges that the unstable material extends to an excessive depth, he may advise the Contractor, in writing, to stabilize the trench bottom with additional select fill or pipe bedding material or to ensure firm support for the pipe or electrical duct by other suitable methods. Payment for such trench stabilization will be made as described for "Authorized Additional Excavation."

e. The open, excavated trench preceding the pipe laying operation and the unfilled trench with pipe in place shall be kept to a minimum length, causing the least possible disturbance. Means of egress shall be located so as to require no more than 25 feet of lateral travel by employees. Ladders shall extend a minimum of 36 inches above the top of the sheeting or be tied down with a grabrail provided.

f. No water shall be allowed to rise in the trench excavation until sufficient backfill has been placed to prevent pipe flotation.

D. Lines and Grades:

1. Excavate for sewers, drains, conduits, pipe lines, walls, foundations, footings, and other structures, including any excavating indicated on the Contract Drawings or necessary, to the lines and grades shown on the Contract Drawings, specified or required.

2. Demolition: Cut pavements, curbs and sidewalks with non-impact tools or other equipment approved by the Engineer. Breaking of pavements, curbs and sidewalks by impact, such as with the use of a ball, is not permitted. When removing sections next to sections that are to remain, sawcut the full depth of the concrete and asphalt.

3. Adequate Space: Do all trimming, grading and other incidental work to the grades and slopes shown on the Contract Drawings, specified or required as

approved by the Engineer. Perform all excavations of sufficient size for the proper execution and inspection of the work. Keep excavation in good condition at all times and fill all voids which may endanger existing structures to the satisfaction of the Engineer.

3.03 FIELD TESTING / QUALITY CONTROL

A. Subgrade Consolidation:

1. Consolidating Suitable Materials: Materials used in the bottom of excavation to replace boggy and other yielding or unsuitable materials, for providing solid and firm foundations for the structures to be built thereon, where approved in writing, may be either select fill or lean concrete.

B. Explosives: Do not use explosives for any clearing, grubbing or excavation work as per Section 31 10 10 – Site Clearing.

C. Authorized Additional Excavation: In case the materials encountered at the elevations shown on the Contract Drawings are not suitable, or in case it is found desirable or necessary to go to an additional depth or to an additional depth and width, carry the excavation to such additional depth and width as the Engineer may direct in writing. Refill such excavated space with either 2,500 psi concrete or compacted select fill materials, as ordered. Where necessary, compact fill materials to avoid future settlement. Use select fill materials meeting the requirements of Section 31 23 23 – Fill and compact to attain a minimum degree of compaction of 95 percent of the maximum dry density as determined by ASTM D1557. Place backfill in lifts not exceeding 9 inches in loose thickness.

D. Unauthorized Excavation: Wherever the excavation is carried beyond or below the lines and grades shown on the Contract Drawings or given by the Engineer, except as specified in Paragraph 3.03C "Authorized Additional Excavation", refill all such excavated space with such material and in such a manner as may be directed by the Engineer to insure the stability of the various structures. Areas excavated beneath all manholes, structures, pipelines or conduits without authority shall be refilled by the Contractor at his own expense with 2,500 psi concrete or compacted select fill material and properly compacted as ordered by the Engineer.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Fencing, Bridging, and Decking

1. All excavations or openings made under this Contract in any public street, park or place, or in any adjoining property, shall be immediately enclosed by a guard fence constructed in a neat and workmanlike manner in accordance with the requirements of Section 32 31 15 – Chain Link Fence. Where a tight board fence is specified, no guard fence will be required, provided there is no delay in the erection of the tight board fence.

2. Wherever a driveway occurs, construct a bridge of adequate strength and width and provide with side railings to span the excavation.

3. Wherever the distance between available crossings over the excavation is, in the opinion of the Engineer, excessive, he may order a temporary foot bridge with side rails to be constructed.

4. At all street intersections, excavations made from the surface shall be decked over in a substantial manner so that traffic can be maintained at all times except as herein provided for. The removal of the pavement and the placing of the decking shall be done during the hours of a day or night which will cause the least inconvenience to adjoining property owners and to public traffic in general. During certain designated hours of the day or night, sections of planking not more than 10 feet in length may be temporarily removed for the purpose of removing Excavated Material, receiving materials of construction or for backfilling.

B. Segregation, Storage, and Disposal of Materials:

1. Segregating:

a. All Unsuitable Material which may be excavated by the Contractor shall be kept separated from suitable Excavated Material or Rock which may be reused on-site or off-site under NYSDEC Pre-Determined Beneficial Use or a Case-Specific BUD per 6 NYCRR Part 360, or other applicable out-of-state agency's Case-Specific BUD, or disposed off-site.

b. Soil sample results greater than 5 ppm lead by TCLP shall be reported to the Engineer immediately. (See Section 01 35 45 – Hazardous Materials Control for implementation of a Community Air Monitoring Program (CAMP) in the event that hazardous levels of lead are detected in soil.)

2. Stockpiling:

a. Excavated Material to be used for backfilling on-site under NYSDEC Pre-Determined Beneficial Use or Case-Specific BUD shall be so piled and placed as not to encumber sidewalks or roadways, or wash away or obstruct the free flow of surface or drainage water. Excavated Material shall not be placed closer to the edge of an excavation than a distance equal to 1-1/2 times the depth of the excavation, unless the excavation is in rock or the sides of the excavation have been sloped or sheeted and shored to withstand the lateral forces imposed by such superimposed loads.

b. Stockpile cover and liner material and installation requirements should be as specified in Section 31 25 10 - Dust, Soil Erosion and Sediment Control.

c. Storage before beneficial use shall not exceed 365 days per 6 NYCRR Part 360.12(a)(3), unless a different time period for storage is approved by NYSDEC.

3. Excess Materials: The Contractor shall make arrangements for transportation and reuse of the soil or Rock on-site or off-site under NYSDEC Pre-Determined Beneficial Use or a Case-Specific BUD per 6 NYCRR Part 360, or applicable out-of-state agency's Case-Specific BUD. If reuse is not an option, only then may the Contractor dispose of excess materials.

C. Sheeting and Bracing Left in Place:

1. All sheeting and bracing in excavations for sewer pipelines, including manholes and chambers, shall be left in place except where otherwise shown on the Contract Drawings, specified or ordered in writing by the Engineer. Sheeting left in place shall be cut off at the elevation shown on the Contract Drawings, or at least 18 inches below final grade. Bracing remaining in place shall be driven up tight.

2. Where it is necessary to remove cross braces to make way for sewer pipe, manholes, and chambers, rebrace the sheeting in a manner approved by the Engineer, but in no case shall sheeting be braced against the sides of pipe or structures, unless approved in writing by the Engineer.

3. Leave sheeting and bracing in place in excavations for structures other than pipe lines where shown on the Contract Drawings, specified or ordered in writing by the Engineer to be left in place. Where such sheeting is to be left in place, the original braces shall not be removed and the sheeting shall be rebraced against the structure unless it is approved by the Engineer.

4. Sheeting and bracing to be left in place shall include all elements of the sheeting and bracing regardless of the type used, except such braces required to be removed to make way for the structure or pipeline being constructed. Where lagging and "soldier" beams are used, the "soldier" beams shall also be left in place.

5. In excavations with vertical sides for the full depth, cut off sheeting left in place at the elevations provided in writing by the Engineer, but in general, such cutoffs shall not be less than 18 inches below the existing ground surface. In excavations with sloped sides above and vertical sides below, cut off sheeting at the top of the vertical sides of the excavation. Cut off timber sheeting by sawing, and steel sheeting or "soldier" beams by burning. Breaking off sheeting will not be permitted.

6. Do not remove sheeting and bracing not shown on the Contract Drawings or specified to be left in place without first obtaining a statement in writing from the Engineer that such sheeting may be removed.

7. No separate payment will be made for sheeting and bracing left in place, the cost thereof shall be included in the price or prices bid for the work under

this Contract, except when separate payment for sheeting and bracing ordered in writing by the Engineer to be left in place is provided for in the Contract Documents.

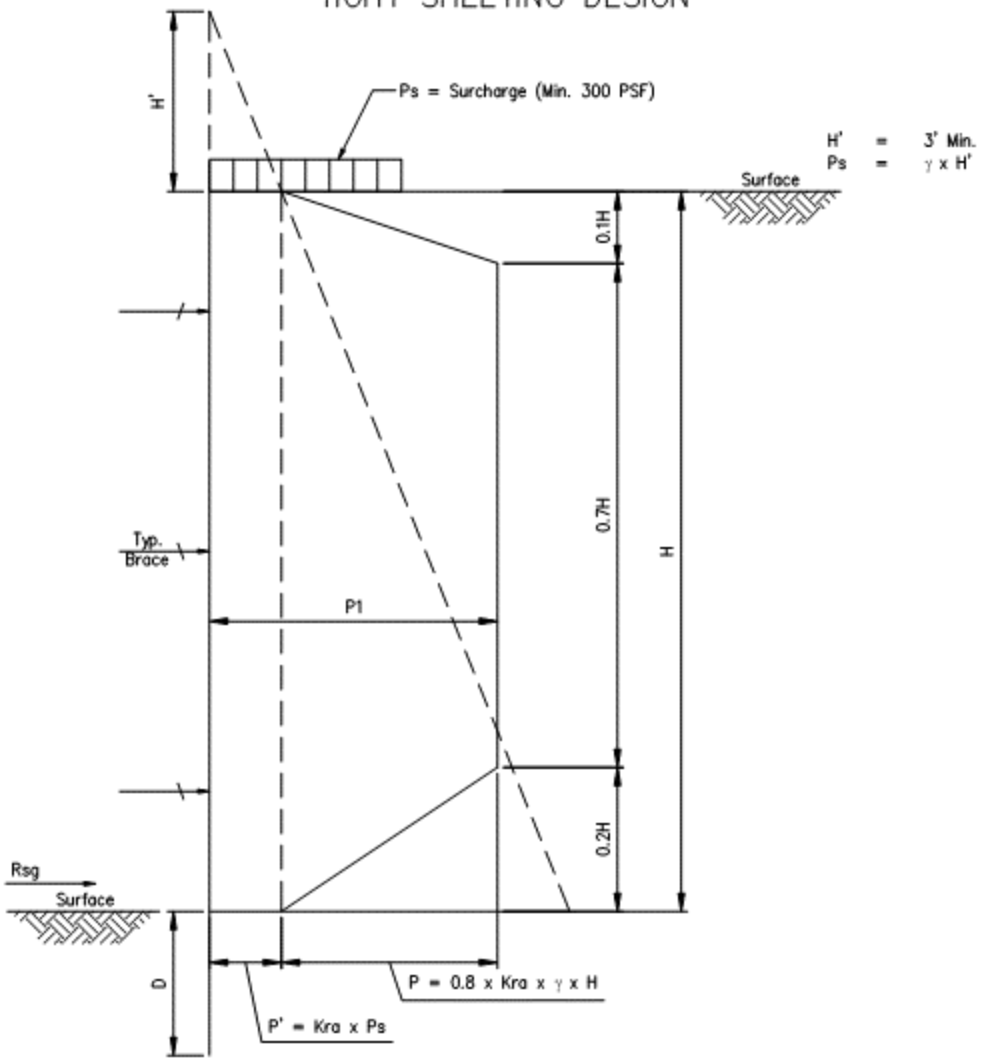
END OF SECTION

ATTACHMENTS A and B show DEP's minimum normal load diagram requirements for sheeting and bracing design during excavation (see Article 1.05).

Attachment A

(Revised 3/22)

MINIMUM LOAD DIAGRAM FOR NON–WATER TIGHT SHEETING DESIGN



δ = Unit Weight of Soil

δw = Unit Weight of Water

δs = Unit Weight of Submerged Soil

ø = Angle of Internal Friction of Soil

$Kra = \frac{(1 - \sin \phi)}{(1 + \sin \phi)}$ For Active Earth Pressure

$Krp = \frac{(1 + \sin \phi)}{(1 - \sin \phi)}$ For Passive Earth Pressure

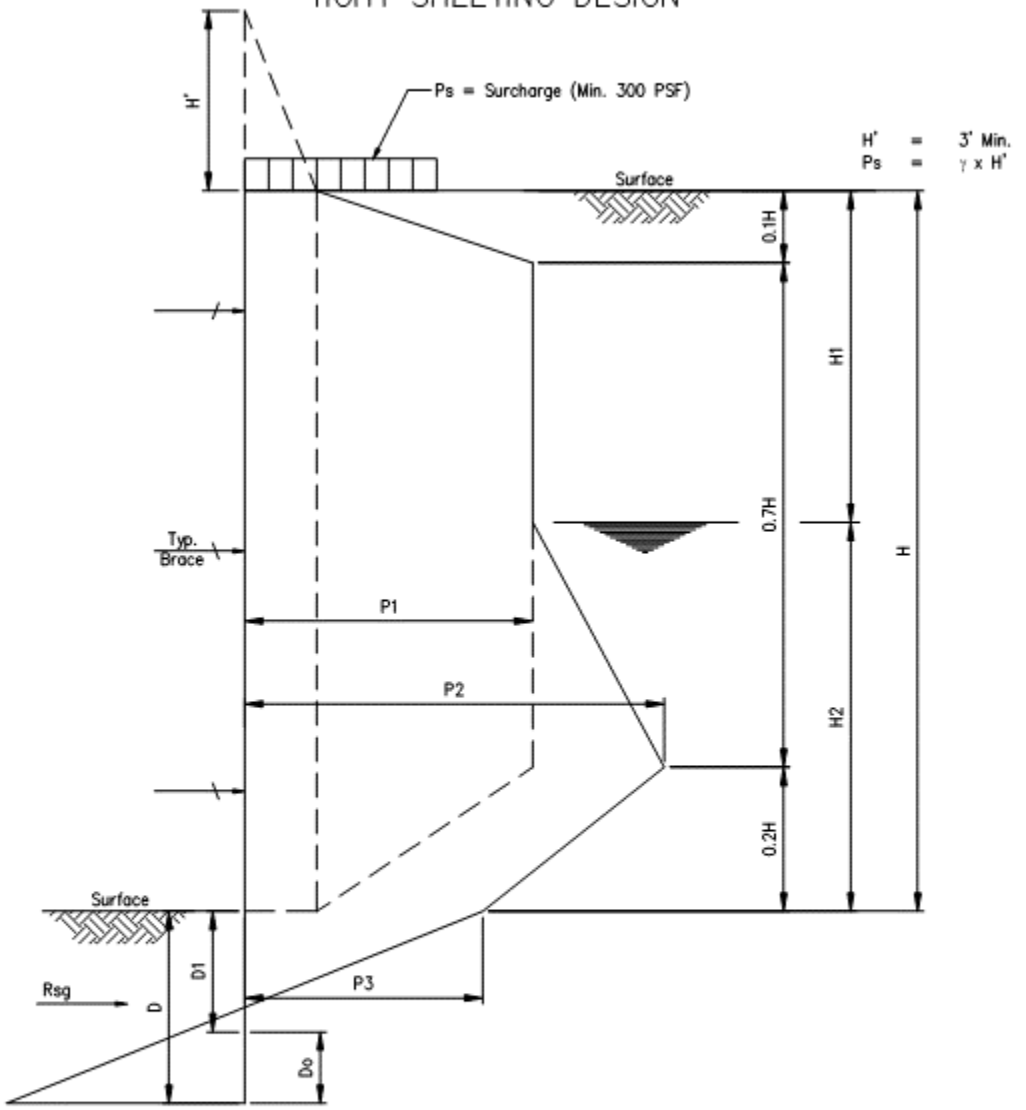
$D = \sqrt{\frac{2\ Rsg}{\delta(Krp - Kra)}}$ (1.3)

(Min. 2'–0")

Attachment B

(Revised 3/22)

MINIMUM LOAD DIAGRAM FOR WATER TIGHT SHEETING DESIGN



$P' = Kra \times Ps$

$P1 = P' + 0.8 \times Kra \times (\delta H1 + \delta sH2)$

$P2 = P1 + \delta w\ (H2 - 0.2H)$

$P3 = \delta w \times H2$

$$D1 = \frac{P3}{\delta s\ (Krp - Kra)}$$

$$Do = \sqrt{\frac{2\ Rsg}{\delta s\ (Krp - Kra)}}$$

$$D = (D1 + Do)\ (1.3)$$

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install, operate and maintain dewatering equipment and systems as specified, shown on the Contract Drawings, or required during the Contract.

B. The Contractor shall provide standby equipment and power supply for maintaining uninterrupted construction dewatering.

C. The Contractor shall install groundwater monitoring wells/piezometers and measure, record and report the levels/hydraulic head of groundwater as required during the project.

D. In order to expedite the regulatory review process for construction dewatering permits, DEP may have initiated the permitting process with authorities having jurisdiction and obtained design-phase dewatering permits or letters of approval.

E. The Contractor shall note that DEP may have made preliminary dewatering quantity estimates in order to obtain the design-phase dewatering permits. Where design-phase dewatering permits are shared with the Contractor, it shall be expressly understood that such design-phase permits are for the Contractor's information only. The City shall be not held liable nor responsible for any damages, and shall not entertain any claims, resulting from information included in the design-phase dewatering permits.

F. The Contractor shall review the design-phase dewatering permits, if any, and shall re-obtain the permits or obtain new permits for execution of the Contract Work. The Contractor shall amend the design-phase dewatering permits or obtain new permits as necessary to accommodate the construction means and methods that will be employed.

G. The Contractor shall not use design-phase dewatering permits to estimate the cost of dewatering for execution of the Contract Work, and shall not include such cost while preparing and submitting the bid. The Contractor shall estimate the cost for dewatering and include such cost in the appropriate bid item. The Contractor shall interpret the geotechnical data provided in the Contract and bid exhibits as appropriate, and perform its own dewatering calculations and estimate dewatering quantities considering its means and methods to be employed for execution of the Contract Work.

H. The Contractor shall not use design-phase dewatering permits to estimate the cost of dewatering for execution of the Contract Work, and shall not include such cost while preparing and submitting the bid. The Contractor shall estimate the cost for dewatering and include such cost in the appropriate bid item. The Contractor shall interpret the geotechnical data provided in the Contract and bid exhibits as appropriate, and perform its own dewatering calculations and estimate dewatering

quantities considering its means and methods to be employed for execution of the Contract Work.

I. The Contractor shall comply with all necessary permits from federal, State and local agencies having jurisdiction for operation of the dewatering system, monitoring groundwater, and disposal of dewatering effluent, and shall bear all costs and schedule impacts associated with maintaining, renewing and modifying the permits.

J. The Contractor shall collect samples of the dewatering effluent as required by the applicable State and local permits and provide the services of a laboratory certified under the New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) for the analyses of the samples collected to determine the quality of dewatering effluent prior to disposal.

K. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 33 00 - Submittal Procedures

B. Section 01 41 00 - Regulatory Requirements

C. Section 01 55 26 - Traffic Control

D. Section 02 24 20 - Soil Sampling and Analysis

E. Section 31 23 16 - Excavation

F. Section 31 23 25 - Rock Excavation

G. Section 31 25 10 - Dust, Soil Erosion and Sediment Control

1.04 REFERENCES

A. Definitions

1. Construction Dewatering: Controlling groundwater levels, hydrostatic pressures and controlling surface water, such that excavation required on the Contract Drawings can be performed to required depths in substantially dry and stable conditions.

2. Dewatering System: System of wells, well points, sumps, ejectors, pumps, piping, power supply, effluent treatment equipment and other equipment designed by the Contractor, submitted to and approved by the Engineer prior to dewatering, that will effectively dewater the site as required herein. Adequate monitoring wells/piezometers shall be included in the dewatering system to verify drawdown levels inside the excavation area and monitor groundwater levels outside the limits of the excavation near adjacent structures.

B. Reference Standards

1. 6 NYCRR Part 750, State Pollutant Discharge Elimination System (SPDES) Permits

2. 6 NYCRR Part 601, Water Withdrawal Permitting, Reporting and Registration (Exclusive of Long Island Wells Regulated Under Part 602 of This Title)

3. 6 NYCRR Part 621, Uniform Procedures

4. ASTM standards applicable to piping, equipment and other items required for a complete dewatering system

1.05 DESCRIPTION

A. Design Requirements

1. The Contractor shall design, install, operate, maintain and remove the dewatering system as necessary to:

a. Lower and maintain groundwater levels and hydrostatic pressures to 2 feet below the prevailing excavation level or to a point no higher than 2 feet above the top of an impermeable stratum, if the subgrade is in the impermeable stratum. Groundwater levels shall be lowered for a time period as deemed necessary by the Engineer to ensure adequate factor of safety for the constructed structure.

b. Maintain stable slopes and subgrade.

c. Control and remove seepage and surface water into excavations.

d. Allow subsequent work to be safely performed and not result in damage to adjacent properties, buildings, structures, utilities and other work.

e. The Contractor shall provide primary and standby power, including all costs for installation, energy and fuel.

f. The Engineer will perform inspections and witnessing of:

1) Testing of sand and silt from dewatering wells.

2) Drawdown and performance testing of Dewatering System.

3) Performance testing of standby power source and backup Dewatering System.

2. The method of dewatering and control of water both inside and outside the excavation shall be selected by the Contractor who shall be solely responsible for the location, arrangement and depth of any system(s) selected to accomplish the Work. The Contractor shall construct protective works as necessary to dewater, cut off porous zones of fill and direct the flow of water from whatever source away from the excavations and adjacent areas. Protective works shall include slurry methods, grouting, clay seepage plugs, toe drains with appropriate filters, deep wells, well points, sumps, dikes, ditches and all supporting features as required, but not specifically shown on the Contract Drawings.

a. The dewatering system shall be designed and implemented so as to maintain a minimum factor of safety against the uplift groundwater pressures in any soil strata. The factor of safety shall be calculated by considering the stabilizing pressure to consist of overburden soil weight alone. The dewatering system shall be maintained operational until the dead weight of the overburden soil plus any completed portion of the structure is able to provide the required factor of safety at static (normal) groundwater level / pressure.

3. The dewatering system shall be designed to treat dewatering effluent to comply with all necessary permits and/or applications for disposal of dewatering effluent. Groundwater testing data is attached in the bid exhibit to the Contract Documents.

B. Regulatory requirements

1. The Contractor shall manage and dispose of all groundwater removed during dewatering activities in accordance with either New York State Pollutant Discharge Elimination System (SPDES) standards set by the New York State DEC for discharge to surface water. The Contractor shall acquire, and update as necessary, all permits and/or applications for water withdrawal and disposal of dewatering effluent. It shall be the Contractor's responsibility to update permits to match their final dewatering system design.

1.06 QUALITY ASSURANCE

A. The dewatering Work shall be performed by an entity specializing in and having experience with installing and operating dewatering systems in similar subsurface conditions for at least 5 years.

B. The dewatering system shall be designed by a Professional Engineer registered in the State of New York having experience in designing a system in similar site conditions.

C. Well drillers shall be licensed in the State of New York.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and the following for the approval by the Engineer:

1. Pre-construction Submittals: A Dewatering Plan shall be submitted to the Engineer for approval, at least 30 calendar days prior to the scheduled date for commencement of the dewatering Work, and to the NYSDEC, as applicable. Approval of the Dewatering Plan by the Engineer or City shall not in any way relieve the Contractor from full responsibility for the complete and adequate design and performance of the dewatering system to provide the necessary construction dewatering. At a minimum, the Dewatering Plan shall include the following:

a. Design calculations confirming the adequacy of the proposed dewatering system, including depths to groundwater within the excavation limits.

b. Calculations and requisite technical data on well screens and filter materials and gradations to demonstrate the adequacy of proposed systems to prevent the pumping of fines.

c. Shop drawings showing the proposed types and planned locations of surface water control and the dewatering system to be used.

d. Shop drawings shall include the arrangements, locations and depths of the dewatering system, a complete description of equipment and materials to be used and the procedures to be followed in

installation, operation and maintenance in relation to the proposed sequence of excavation, foundation construction and backfilling.

e. The standby equipment and standby power supply details.

f. The proposed locations and sizes of effluent treatment equipment, effluent flow equalization tanks and discharge of water.

g. Location and size of sumps, ditches and water discharge lines, including their relation to water disposal points.

h. Submittals shall also include discharge details, metering, and monitoring schedules and the details of the settling tank and oil/water separator.

i. Methods and equipment to be used for drilling, construction, and development of wells and piezometers.

j. Protocols to be followed for the sampling and analysis of dewatering effluent, and the name and qualifications of the laboratory that will be testing the quality of dewatering effluent prior to disposal.

k. Protocols to be followed for treatment of effluent in conformance with the requirements of the applicable permits.

2. As required in Section 02 24 20 - Soil Sampling and Analysis, the Contractor shall submit a completed EH&S Drilling and Boring Checklist for approval to the Engineer

3. As-built Submittals: Prior to the start of construction dewatering, submit as-built conditions of the dewatering system. As-built data are to include but are not limited to:

a. Plans and sections showing as-built locations, and surveyed elevations of the dewatering system and its components.

b. Drawings to indicate changes made to the original shop drawings to accommodate field conditions and to comply with design standards.

c. Details of installation including dimensions and materials used, description and drawings of all installations, all procedures, soil strata encountered and logs with descriptions of soil samples and stratification.

d. Details of each sump, well, well point, observation well, and piezometer installed, including, but not limited to, the diameters of the borehole and the components, screen type, screen opening size, screen top and bottom elevations, details of filter, seal and grout, pump type, and capacity if installed within. These details should be provided to the Engineer within a week of installation of each entity. The details shall be re-submitted if any part of the entity changes during construction.

e. Details of abandoning each sump, well, well point, observation well, and piezometer after its use has been completed.

4. Regulatory Compliance: Prior to the start of construction dewatering, submit a report comparing site groundwater quality data with the water quality standards to be complied with under permit(s) as applicable to the project. The permitting requirements to be considered under the Work of this section include, but may not be limited to:

a. NYSDEC SPDES Discharge Permit(s) - General or Individual Permits - for dewatering effluent or storm water discharges from construction activities at the project site.

b. Water Withdrawal, if applicable, in association with construction dewatering.

c. The Contractor shall be responsible for compliance with all dewatering permit requirements including renewals once construction dewatering begins.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The settling tank shall be concrete or steel as manufactured by Rockford, Belvidere, IL or an approved equal.

B. The oil/water separator shall be concrete or steel as manufactured by Rockford, Belvidere, IL or an approved equal.

2.02 MATERIALS / EQUIPMENT

A. Materials and equipment used in the dewatering system shall adhere to accepted industry standards and be in good operating condition and able to perform satisfactorily over the required duration of construction dewatering.

B. Back up equipment for the dewatering system shall be identical to the primary equipment and shall be available in operating condition at all times.

C. Pipes and well screens shall consist of Schedule 40 PVC or stronger.

D. Sand shall consist of clean, single-size filter sand of adequate gradation.

E. Grout shall consist of cement-bentonite grout of adequate mix proportion and consistency. Seals shall consist of bentonite pellets.

F. Pumps, meters, hoses and controls shall be suitable for the intended purpose and application.

G. Power supply and effluent discharge are included in this Work.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Construction dewatering is required to protect foundation subgrades and to maintain dry and stable conditions for construction. The Contractor shall maintain a continuous and completely effective Dewatering System for the required time as specified in Section 31 23 16 - Excavation.

B. The Contractor shall obtain and pay for all permits, applications and licenses required by law that are associated with the disposal of dewatering effluent, including but not limited to the NYSDEC SPDES Permit, if applicable. The Contractor shall coordinate with the CM and DEP to obtain or modify permit(s), if necessary, sufficiently in advance of dewatering system startup. The Contractor shall also maintain the permits by applying for and following up on the applications for modifying or renewing the permits, if necessary, during the period of performance.

C. The Contractor shall coordinate the operation of the dewatering system with any other Work, including those by NYCDEP and other Contractors.

D. The Contractor is responsible for monitoring dewatering efforts to determine if the Contract and related permit requirements are being met. The Contractor shall provide observation wells and other means to monitor the dewatering as detailed in the Dewatering Plan.

E. Surface areas adjacent to the excavation shall be graded and/or curbed to prevent flow of surface water into the excavation.

F. Open pumping with sumps and ditches resulting in boils, loss of fines, softening of the ground or instability of slopes will not be permitted.

G. The Contractor shall select and supply Personal Protective Equipment (PPE) in accordance with the Contractor's Site Health and Safety Plan.

3.02 IMPLEMENTATION

A. The dewatering system shall provide for an uninterrupted flow of pumped water and shall be maintained and pumped as necessary to drawdown and maintain the groundwater levels as specified. Unless otherwise specified, pumping shall maintain those depressed levels until the permanent under drainage system has been installed, tested, accepted and is operational or until the permanent structure, or a portion thereof, is capable of withstanding hydrostatic pressures as determined by the Engineer.

B. The Contractor shall furnish, operate and maintain sufficient drainage and pumping facilities to dewater the site and its underlying soil. Dewatering operations shall operate in such a manner so that the excavation can proceed while maintaining stable slopes and the designed lateral support for the perimeter support of excavation walls, without disturbing the bearing subgrades for the structure and provide stable conditions. The ground water level as measured in observation wells shall be lowered and maintained at least two feet below the prevailing excavation level, or it shall be lowered to a point no higher than 2 feet above the top of impermeable stratum if the subgrade is in the impermeable stratum.

C. The dewatering system shall be installed and operated in such a manner as to avoid the movement of fines or loss of ground below the bearing level and shall not influence the stability of surrounding areas. Well points and deep wells shall be properly sanded in and sumps shall be sheeted and provided with proper filter material.

D. Any sign of subgrade disturbance due to seepage or unaccountable reduction in effluent flow rate shall be immediately reported to the Engineer and steps immediately taken to correct the condition.

E. The Contractor shall install observation wells / piezometers and monitor groundwater lowering at nearby structures due to construction dewatering. Any damage caused to nearby structures due to construction dewatering shall be repaired by the Contractor at no cost to the City.

F. Surface Water

1. Surface water on and around the site shall be collected into local sumps by means of trenches, pipes, or other means. The Contractor shall discharge the water into the City wastewater collection system. Direct surface water to minimize surface erosion, ponding and softening of slopes and berms, including haul roads and equipment working stations. Slope protection by means of polyethylene sheets, held in place by tires or otherwise, shall be provided locally as required. At the perimeter of the excavation, surface water is to be directed into the storm sewer system and not permitted to enter the excavation. Curbs shall be maintained and, where necessary, extended across intersections, curb cuts and defective curb sections. Surface cracks in the adjacent streets are to be sealed and re-sealed as necessary. Should adjacent settlement occur during the work, curbs shall

be raised or water-tight mounds shall be installed as directed by the Engineer to prevent flow into the site. Measures for preventing the pollution of and discharging storm water shall be in accordance with Section 31 25 10 - Dust, Soil Erosion and Sediment Control.

a. If surface water flows to a point across a potentially contaminated surface (e.g., contaminated or hazardous soils) or otherwise unsuitable/impermeable surface (e.g., mud mat), removal of said water via pumping to storm sewers shall require the appropriate dewatering permits from the NYSDEC and/or Town of Mount Pleasant. The Contractor shall obtain all necessary permits in a timely manner so as not to delay the Work.

G. Pretreatment of dewatering effluent

1. The Contractor shall provide appropriately sized settling tanks to collect and store dewatering effluent commensurate with dewatering discharge rates to allow for settlement of suspended solids and sampling as required by disposal/discharge criteria. The tanks shall be equipped with an overflow collection system to prevent accidental release of dewatering effluent. Routine inspection of the tanks shall be carried out daily to ensure that tank integrity is being maintained, and that all valves or tank openings are properly locked out to avoid accidental discharge. Settling tanks shall be cleaned frequently to prevent excess deposition of solids which could overflow from the tank. Removed solids shall be classified and disposed of in accordance with the requirements of Section 02 24 20 - Soil Sampling and Analysis. Transportation and Disposal including waste manifests shall be in accordance with Section 31 23 16 - Excavation.

   a. The settling tank shall be sized based upon the maximum groundwater flow times a 1.5 safety factor.

2. The Contractor shall provide appropriately sized oil/water separators to prevent discharge of hydrocarbons, grease and other floatable materials to surface water or the sewer system. Oil/water separators shall be cleaned frequently and collected materials classified and disposed of in accordance with Sections 02 24 20 - Soil Sampling and Analysis and 31 23 16 - Excavation requirements for manifests and material transport and disposal.

   a. The oil/water separator shall be sized based upon the maximum groundwater flow times a 1.5 safety factor.

3. The Contractor shall provide treatment for, or remove from the site to an approved disposal facility, all dewatering effluent or groundwater which exceeds any limit set for surface water or sewer discharge, whichever is applicable. Classification and disposal shall conform to Sections 02 24 20 - Soil Sampling and Analysis and 31 23 16 - Excavation requirements for manifests and material transport and disposal.

H. Disposal of Dewatering Effluent

1. Dewatering effluent may be affected by rainfall. The Contractor shall provide adequate equalization and holding tanks to allow work to proceed in the case of restricted discharge capability during rain events.

2. The Contractor shall provide sufficient clean water to flush all sewers and drains when necessary. If any sewer, drain, catch basin, or inlet becomes filled or partially filled with sediment or debris, the Contractor shall promptly and satisfactorily remove such deposits.

3. The Contractor shall collect dewatering effluent samples as required by the permits and the Dewatering Plan. If pretreatment, other than oil/water separators and settling tanks, is required, the Contractor shall continue to collect effluent samples during dewatering operations, and analyze for all listed parameters at intervals based on dewatering discharge volume as a verification of discharge compliance. Intervals will be as defined in the Dewatering Plan. A copy of all analytical results shall be submitted to the Engineer for review and approval, no later than one day after receipt of such data. The Contractor shall provide for prompt sampling and turn-around times so as not to delay the project, but in no case shall turn-around time be longer than 5 calendar days.

3.03 FIELD TESTING / QUALITY CONTROL

A. The Contractor shall determine the presence of contaminants in dewatering effluent, including the quantity of fines in the pumped water, by sampling and analyzing in accordance with permit requirements, or once every two weeks, whichever is more frequent.

B. The fines content should be measured in each sump, well or well point being pumped. The permissible maximum fines content is 5 parts per million (ppm) as measured by the Rossum Sand Content tester. If the fines content is exceeded, the Contractor shall modify or re-install the well or wellpoint to satisfy the requirements.

C. The Contractor shall measure water levels periodically in observation wells / piezometers installed adjacent to nearby structures to ensure drawdown outside the excavation is within allowable limits in accordance with applicable permits.

D. A sufficient number of observation wells shall be installed and water levels monitored by the Contractor, at least weekly, to demonstrate that the goals of the Dewatering System are being met. If applicable, the Contractor may make use of existing observation wells as shown on the Contract Drawings.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. The Contractor shall be prepared to modify the dewatering system and methods as required by actual field conditions encountered during construction, at no

additional cost to the City. Any component of the dewatering system that malfunctions or is damaged during its operation shall be promptly repaired or replaced by the Contractor at no additional cost to the City.

B. All wells and piezometers shall be abandoned at the completion of the work, except as directed by the Engineer, in accordance with NYSDEC guidelines.

C. All wells shall be abandoned in place and all other portions of the dewatering system shall be removed by the Contractor after completion of dewatering activities and in accordance with NYSDEC requirements.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Fill Work includes furnishing, placing and compacting all fill material necessary to bring excavations and site work to final grade as shown, specified or required.

B. Clean fill material from an off-site source shall be non-hazardous and shall meet the requirements of this Section.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 74 20 - Construction Waste Management

B. Section 02 24 20 - Soil Sampling and Analysis

C. Section 03 30 00 - Cast-in-Place Concrete

D. Section 03 05 19 - Geosynthetics for Earthwork

E. Section 31 25 10 - Dust, Soil Erosion and Sediment Control

F. Section 32 90 00 - Planting

1.04 REFERENCES

A. Definitions

1. Case-Specific Beneficial Use Determination (BUD): Under 6 NYCRR Part 360, Section 360.12(d), NYSDEC sets forth the requirements for petitioning NYSDEC to obtain a Case-Specific BUD, and the criteria for reviewing, granting, or denying of the BUD. For reuse of a solid waste to be determined a beneficial use, the petition must satisfy all criteria outlined under 6 NYCRR Part 360, Section 360.12(d).

2. Fill: Soil and similar material excavated or brought to the project site for the purposes of construction. All fill material must meet the requirements of this Section.

3. Pre-Determined Beneficial Use for fill material: Under 6 NYCRR Part 360, Section 360.13(b) Waste cessation. "Fill material ceases to be solid waste in accordance with the following:

   a. Restricted–use fill and limited-use fill – once delivered to the site of reuse;

   b. General fill generated outside of the City of New York – once a determination that it is general fill has been made;

   c. General fill generated within the City of New York – once delivered to the site of reuse."

   d. Under 6 NYCRR Part 360, Section 360.13 (c), Exemption for on-site reuse of fill material. "Fill material used as backfill for the excavation from which the fill material was taken, or as fill in areas of similar physical characteristics on the project property is exempt from regulation" under 6 NYCRR Part 360. "If fill material exhibits historical or visual evidence of contamination (including odors), and will be used in an area with public access, the relocated fill material must be covered with a minimum of 12 inches of soil or fill material that meets the criteria for general fill, as defined in" Subdivision 360.13, Special requirements for pre-determined beneficial use of fill material. Refer to Section 02 24 20 - Soil Sampling and Analysis for sampling requirements, including a list of parameters to be analyzed for soils to be reused on-site, or soils to be reused or disposed off-site.

4. Suitable Material: Any material whose composition is satisfactory for use as fill. Any mineral (inorganic) soil, blasted or broken rock and similar materials of natural or man-made (i.e. recycled) origin, including mixtures thereof, are considered suitable materials. Determinations of whether a specific natural material is suitable shall be made by the Engineer on the above basis.

5. Unsuitable Materials: any material containing vegetable or organic matter such as muck, peat, organic silt, topsoil or sod, that is not satisfactory for use as fill material. Certain man-made deposits of industrial waste, or contaminated materials may also be determined to be unsuitable materials.

B. Reference Standards

1. ASTM C33 – Standard Specification for Concrete Aggregates
2. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
3. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
4. ASTM C330 - Lightweight Aggregates for Structural Concrete
5. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils
6. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
7. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m^3))
9. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
10. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
11. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Cylinders
12. ASTM D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)

13. ASTM D6024 - Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
14. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
15. NYSDEC regulations, 6 NYCRR Part 375, Environmental Remediation Programs
16. NYSDEC regulations, 6 NYCRR Part 360, Solid Waste Management Facilities General Requirements
17. New York State Building Code
18. New York State Standards and Specifications for Erosion and Sediment Control (aka "Blue Book") (NYSDEC, November 2016, or latest version)

1.05 DESCRIPTION

A. Recycled materials that the Engineer has evaluated and approved for general use shall be considered to be Suitable Material subject to the conditions for use as determined by the City. In general, the use of recycled materials must be sanctioned by NYSDEC, usually in the form of a BUD. See definition above.

B. Suitable fill material from an off-site source shall be non-hazardous and shall come from the following hierarchical sources:

1. Other DEP projects that have available, excess suitable materials;
2. ~~The NYC Clean Soil Bank, located at 830 Forbell Street, Brooklyn, and managed by the Mayor's Office of Environmental Remediation (OER);~~
3. Beneficial Use Facilities; and
4. Commercial Facilities.

1.06 QUALITY ASSURANCE

A. Testing: The Contractor shall retain the services of an independent materials testing laboratory to perform the following laboratory and field tests.

B. All materials used in construction, whether brought to the site or developed from on-site sources, shall be tested for optimum moisture-maximum density curve, and reports of the test results for each source shall be submitted promptly. The tests shall be as follows:

Test	ASTM Standard	Tests Per Volume Delivered
Gradation	D422	1 per 200 C.Y.
Compaction or Density	D1557	1 per 200 C.Y.

C. Acceptability of completed compaction shall be demonstrated by tests performed by the Contractor and accepted by the Engineer. The minimum number of tests shall be determined by quantity of material placed, and reports of the test results shall be submitted promptly. The Contractor shall perform either of the following tests subject to the approval of the Engineer:

Test	ASTM Standard	Tests Per Volume Placed
In-Place Density	D2167 D6938	1 per 200 cy

D. The Contractor shall engage the services of a testing laboratory, with the qualifications required by Section 03 30 00 - Cast-in-Place Concrete, and experienced in design and testing of flowable fill materials and mixes, to perform material evaluation tests and to design mixes for flowable fill. A trial mix shall be performed to verify the flowable fill mix design. The trial mix shall also report slump, air content, yield, cement content, and dry unit weight per ASTM C143 and ASTM D6023.

E. Any fill material being brought to the site that is composed of soil or a mixture of soil (excluding gravel, crushed stone, limestone screenings, other granular materials or flowable fill), as well as any soil being used for drainage fill, common fill and pipe bedding for small piping, must comply with the following protocol:

1. Testing shall be performed on all soil brought on-site (fill and topsoil) and shall demonstrate chemical quality meeting 6 NYCRR Part 360, Section 360.13(f), Table 2: Fill Material Beneficial Use, specifically General Fill maximum concentration levels, unless otherwise approved by the Engineer.

2. Chemical analyses shall include the 6 NYCRR Part 375-6.8(b) compounds, including volatile organic compounds and asbestos, as detailed in Section 02 24 20 - Soil Sampling and Analysis. All analyses shall be performed by a testing laboratory certified by the New York State Department of Health Environmental Laboratory Accreditation Program (NYSDOH-ELAP). Based on visual observation, the volume of physical contaminants, if present, shall also be recorded

3. The frequency of testing per volume of fill shall be in accordance with 6 NYCRR Part 360.13 (e)(1), Table 1, Minimum Analysis Frequency for Fill Material purchased from a registered/permitted processing or recycling facility.

F. When testing is required to confirm the reuse of on-site excavation spoils under a Case-Specific BUD, sample the soils in accordance with NYSDEC requirements.

1.07 SUBMITTALS

A. The Contractor shall submit shop drawings for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Name and location of all suppliers.
2. Certificate of compliance with standard specified for each source of material.
3. The Contractor shall submit all laboratory analytical reports, which shall include a Summary Table listing the analytical results with highlighted exceedances as defined in 6 NYCRR Part 360, Section 360.13 (f), Table 2: Fill Material Beneficial Use, as applicable.
4. Prior to stockpiling or placing of select fill materials at the job site, submit for approval approximately 100-pound samples representative of the fill at the proposed borrow source. In addition, submit documentation of the availability of the required fill quantities at any proposed borrow source.
5. Submit optimum moisture – maximum density curves and reports for all fill materials before placement of fill.
6. Results of all compaction tests for fill placement.
7. Mix design for flowable fill, including all materials used and trial mix test results.
8. Certification by the lightweight fill producer of the gradation, dry loose unit weight, dry compacted unit weight and Los Angeles Abrasion Test lost for the proposed lightweight fill source.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered to the site shall be stored in a manner to prevent contamination and segregation.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. General

1. Backfill shall be composed of suitable materials as defined in this Section.
   a. On-site Materials: Material to be excavated and proposed for reuse as fill under Pre-Determined Beneficial Use must meet the

requirements of 6 NYCRR Part 360, Section 360.13 (a), Applicability, Section 360.13 (b), Waste Cessation, or Section 360.13 (c), Exemption for On-site Reuse of Fill Material. If these criteria cannot be met, material shall meet Section 360.12(d), Case-specific beneficial use determinations - general. Fill may require sampling and analyses in accordance with Section 02 24 20 – Soil Sampling and Analysis. The Contractor shall maximize reuse of soil on-site for backfilling rather than import soil from other sources.

b. Off-site Imported Materials: Fill that is brought on site to be used as backfill must meet the requirements of 6 NYCRR Part 360, Section 360.13 (f), Table 2: Fill Material Beneficial Use for General Fill.

2. Follow common fill requirements whenever drainage or select fill is not specified. Determine and obtain the approval of the Engineer for the appropriate test method where more than one compaction test method is specified.

3. Do not use wet or frozen material for backfilling.

4. The maximum stone size shall be two-thirds of the thickness of the backfill lift, but in no case shall material containing stones over 10 inches in the largest dimension be used for backfill.

B. Drainage Fill

1. Use clean gravel, crushed stone, or other suitable material conforming to the gradation specified for drainage fill. Clay and fine particles are unacceptable in drainage fill. Provide drainage fill that complies with the following gradation limits:

U.S. Standard Sieve	Percent Passing By Weight
1-1/2 inch	100
1 inch	95-100
1/2 inch	45-65
#4	5-15
#16	0-4

C. Select Fill

1. Use gravel, crushed stone, limestone screenings or other granular or similar materials, as approved, which can be readily and thoroughly compacted to not less than 95 percent of the maximum dry density obtainable by ASTM D1557. Very fine sand, uniformly graded sands and gravels, or other materials that have tendency to flow under pressure when wet are

unacceptable as select fill. Provide select fill that complies with the following gradation limits:

U.S. Standard Sieve	Percent Passing By Weight
2 inch	100
1-1/2 inch	90-100
1 inch	75-95
1/2 inch	45-70
#4	25-50
#10	15-40
#200	5-15

D. Common Fill

1. Material from on-site excavation may be used as common fill provided that it can be readily compacted to not less than 90 percent of the maximum dry density obtainable by ASTM D1557, and does not contain unsuitable material as per Article 1.04.A.5 Select fill may be used as common fill at no change in the Contract Price.

2. Granular on-site material that complies with the following gradation limits may be used as granular common fill:

U.S. Standard Sieve	Percent Passing By Weight
3 inch	100
#10	50-100
#60	20-90
#200	0-20

3. Cohesive site material may be used as common fill as follows:

   a. The gradation requirements do not apply to cohesive common fill.

   b. Use material having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20, as determined by ASTM D4318.

4. All material used as common fill is subject to approval by the Engineer. If there is insufficient suitable material on site, import whatever additional material is required which conforms to the sections, at no additional cost to the City.

E. Pipe Bedding

Refer to each Piping Specification for the pipe bedding requirements.

a. Section 33 05 33.13 – Corrugated-Wall, Smooth-Interior HDPE Gravity Pipe.

b. Section 33 42 10 – Reinforced Concrete Sewer Pipe

c. Section 40 05 19 – Ductile Iron Cast Iron Pipes

F. Lightweight Fill

1. Lightweight fill shall be a lightweight aggregate produced by the rotary kiln method and meeting the requirements of ASTM C330. No byproduct slags or cinders are permitted.

2. The material shall meet the grading requirements of ASTM C330, Table 1, Coarse Aggregate: 3/4 inch to No. 4.

3. Dry loose unit weight shall be maximum of 55 pcf. Dry compacted unit weight shall be a maximum of 60 pcf when measured by a one-point test performed in accordance with ASTM D698.

4. Maximum Los Angeles Abrasion Test loss of 50 percent when tested in accordance with ASTM C131 (B grading).

G. Flowable Fill

1. Flowable fill (also known as controlled low strength material) shall be a uniform mixture of sand, Type II Portland cement, fly ash, slag, admixtures, and water. The mix design shall produce a flowable material with little or no bleed water which produces a minimum compressive strength of 50 psi and maximum compressive strength of 100 psi at 56 days. The cured material shall be excavatable and have a maximum dry unit weight of 100 pounds per cubic foot. Slump shall be from 7 inches to 10 inches.

2. Admixtures specifically designed for flowable fill shall be used to improve flowability, reduce unit weight, control strength development, reduce settlement and reduce bleed water. Admixtures shall be:

a. Rheocell-Rheofill manufactured by BASF;

b. DaraFill manufactured by W.R. Grace Construction Products;

c. Or approved equal.

3. All other materials shall be as specified in Section 03 30 00 - Cast-in-Place Concrete.

H. Coarse Select Fill (Non-Frost Susceptible Structural Fill)

1. Use #3 Stone in accordance with ASTM C33, angular gravel, crushed stone, limestone screenings or other granular or similar materials, as approved,

which can be readily and thoroughly compacted to not less than 95 percent of the maximum dry density obtainable by ASTM D1557. Fine sand, uniformly graded sands and gravels, or other materials that have tendency to flow under pressure when wet are unacceptable as coarse select fill. Provide coarse select fill that complies with the following gradation limits:

U.S. Standard Sieve	Percent Passing By Weight
2-1/2 inch	100
2 inch	90-100
1-1/2 inch	35-75
1 inch	0-15
1/2 inch	0-5

2. All fill to be free of debris, organic, or deleterious material.

3. All coarse select fill shall be enclosed on all sides by geotextile as outlined in Section 31 05 19 – Geosynthetics for Earthwork.

4. The location, depth, and thickness of coarse select fill is stated on contract drawings. All course select fill shall be underlain with select fill, compacted to the percentage of the maximum dry density stated in this specification, and rated for a minimum compressive bearing strength as outlined in the contract documents.

I. Riprap

1. Riprap shall meet the requirements of the NYSDOT Standard Specifications Section 733-22.

J. Compaction Equipment

1. Equipment and Methods: Perform all compaction with suitable approved equipment and methods.

2. Compact clay and other cohesive material with sheep's-foot rollers or similar equipment where practicable. Use handheld pneumatic tampers elsewhere for compaction of cohesive fill material.

3. Compact low cohesive soils with pneumatic-tire rollers or large vibratory equipment where practicable. Use small vibratory equipment elsewhere for compaction of cohesionless fill material.

4. Do not use heavy compaction equipment over pipelines or other structures, unless the depth of fill is sufficient to adequately distribute the load.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All stockpiled materials shall be adequately handled as required in Section 31 25 10 – Dust, Soil Erosion and Sediment Control.

B. No material shall be placed until satisfactory test reports for material type and compaction requirements have been approved by the Engineer.

C. Warning tape/ribbon shall be placed and/or restored as required when backfilling new and existing utility lines.

3.02 IMPLEMENTATION

A. Backfill all excavations to the original surface of the ground or to such other grades as may be shown or required. For areas to be covered by lawn mix, leave or stop backfill 12 inches below the finished grade or as otherwise required to provide adequate depth of lawn mix to satisfy the requirements of Section 32 90 00 – Planting.

B. Remove from all backfill, and from the space being backfilled, any compressible, putrescible, or destructible rubbish and refuse before backfilling is started. Dispose of the rubbish and refuse in accordance with the requirements of Section 01 74 20 – Construction Waste Management.

C. Leave sheeting and bracing in place or remove as the Work progresses, as shown in the Contract Drawings, specified or directed by the Engineer.

D. Do not permit backfilling construction equipment to travel against or over cast-in-place concrete structures until the specified concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, the above restriction may be modified provided the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.

E. Electrical Duct and Structure Bedding

1. All electrical ducts and precast manhole bases shall be bedded in well graded, compacted, select fill material. Select fill shall be placed in uniform layers not greater than 9 inches in loose thickness and compacted in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D1557. Bedding thickness shall be not less than 6 inches after compaction. Bedding below electrical ducts shall extend the full width of the trench.

2. Existing underground structures, tunnels, conduits and pipes crossing the excavation shall be bedded with compacted select fill material. Place bedding material under and around each existing underground structure, tunnel, conduit or pipe and extend underneath and on each side to a distance equal to the depth of the trench below the structure, tunnel, conduit or pipe.

3. Cast-in-place manhole bases and other foundations for structures shall be cast against a concrete work mat in clean and dry excavations, unless otherwise shown, specified or required.

F. Pipe Bedding and Initial Backfill

1. Place select fill by hand for initial pipe backfill from top of bedding to 1 foot over top of pipes in uniform layers not greater than 6 inches in loose thickness. Tamp under pipe haunches and thoroughly compact in place the select fill with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D1557.

2. Do not place stone fragments larger than 2-inch size in the pipe bedding or in the backfill to 1 foot over the top of pipes, nor any stone fragments larger than 3-inch size nearer than 2 feet from any pipe, conduit or concrete wall.

3. Pipe bedding containing very fine sand, uniformly graded sands and gravels, or other materials that have a tendency to flow under pressure when wet is unacceptable.

4. Bed pipelines or electrical ducts placed in short tunnels in select fill, flowable fill, or 2500 psi concrete. Completely fill the remainder of the annular space between the outside of the pipe wall and the tunnel wall with select fill, flowable fill, suitable job-excavated material, or 2500 psi concrete, as approved. Pipes and ducts in short tunnels shall be supported to permit placing and compaction of backfill.

G. Placement of Flowable Fill

1. Flowable fill shall be batched and premixed by an approved producer, dispensed from ready-mix trucks, and placed by approved methods and equipment.

2. Flowable fill shall be placed so as to completely fill the space to receive it with no trapped air pockets or other voids. Positive means of allowing air to escape shall be provided where necessary. Where placed against and around existing structures, lift heights shall be limited so as not to overload the structure. Lift heights shall be as approved by the Engineer.

3. Where flowable fill is placed around piping and other elements subject to floating within the fill, positive means shall be taken to provide temporary balancing loads to prevent uplift, or fill lift heights shall be limited to prevent uplift.

4. Application of loads or placement of other fill materials or concrete on top of flowable fill shall not occur until the flowable fill surface is determined to be suitable for loading per ASTM D6024.

H. Trench Backfill

1. Backfill trenches from 1 foot over the top of the pipe, from the top of electrical duct bedding or as shown to the bottom of pavement base course, subgrade for lawns or lawn replacement, to the top of the existing ground surface or to such other grades as may be shown or required. Backfill trenches as soon as, in the opinion of the Engineer, it can be done without injury to the concrete or pipe lines.

2. Provide select fill, suitable job-excavated material or other material, as specified and as approved for trench backfill.

3. Depth of Placement - General: Except under pavements, walkways, railroad tracks, and street or highway appurtenances, or as otherwise specified, place trench backfill in uniform layers not greater than 9 inches in loose thickness and thoroughly compact in place using suitable mechanical or pneumatic equipment. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D1557.

4. Depth of Placement - Traffic Areas and Under Utilities: Where pavements, walkways, railroad tracks and street or highway appurtenances are to be placed over trenches and under utilities or utility services crossing the trench, provide trench backfill using select fill placed in uniform layers not greater than 9 inches in loose thickness and thoroughly compacted in place with equipment as specified above. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D1557.

5. Depth of Placement - Undeveloped Areas: In undeveloped areas and where select fill material or hand-placed backfill are not specified or required, place suitable job-excavated material or other approved backfill in lifts not exceeding 12 inches in loose thickness. When the trench is full, consolidate the backfill by jetting, spading, tamping or puddling to ensure complete filling of the excavation. Mound the top of the trench approximately 12 inches to allow for consolidation of backfill.

6. Backfill trenches in such a way as to prevent dropping material directly on top of any conduit or pipe through any great vertical distance. Do not allow backfilling material from a bucket to fall directly on a structure or pipe and, in all cases, lower the bucket so that the shock of falling earth will not cause damage.

7. Break up lumps and distribute any stones, pieces of crushed rock or lumps which cannot readily be broken up, throughout the mass so that all interstices are solidly filled with fine material.

8. Retain backfill in trenches by temporary bulkheads only and remove them as the backfilling progresses. Do not make bulkheads of stone.

9. Do not cover sewers, drains, basin connections, ends of sewers and branches until the Engineer orders or gives permission to backfill.

10. After completion of backfilling in City streets, remove all surplus material, and regrade and leave free, clear, and in good order all roadways and sidewalks. Deposit and compact a temporary surface of asphalt, or other equivalent and suitable material to a depth of six inches on all backfilled areas where ordered by the Engineer in writing. Until areas are restored to their original condition, maintain the surface of the temporary pavement in good and safe condition and promptly fill all depressions caused by settlement of the backfill with the temporary surfacing materials and compact the same. Wet the temporary surface by spraying with water when necessary to prevent a dust nuisance.

I. Structure Backfill

1. Backfill excavations as soon as, in the opinion of the Engineer, it can be done without injury to the concrete or structures.

2. Use select fill underneath all structures, and adjacent to structures where pipes, connections, electrical ducts and structural foundations are to be located within this fill. Use select fill beneath all pavements, walkways, and railroad tracks, and extend to the bottom of pavement base course or ballast.

   a. Place select fill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable approved mechanical or pneumatic equipment.

   b. Compact select fill to not less than 95 percent of the maximum dry density as determined by ASTM D1557.

3. When shown on the Contract Drawings, or approved by the Engineer, lightweight fill shall be used to raise the grade in areas that are to support pavements, walkways, railroad tracks and other structures.

   a. Place lightweight fill in uniform horizontal layers not greater than 12 inches in loose thickness.

   b. Lightweight fill shall be compacted by four complete coverages with an approved smooth drum vibratory roller having a minimum static weight of 14,000 pounds, a minimum dynamic force of 23,000 pounds, and a total force not less than 5,500 pounds per foot of compactor drum width.

4. Use of common granular fill adjacent to structures in all areas not specified above, unless otherwise shown or specified. Select fill may be used in place of common granular fill at no additional cost.

a. Extend such backfill from the bottom of the excavation or top of bedding to the underside of the lawn mix for seeded, sodded or hydroseeded areas, the top of previously existing ground surface or to such other grades as may be shown or required.

b. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable equipment, as specified above.

c. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D1557.

5. In unpaved areas adjacent to structures, for the top 1 foot of fill directly under the lawn mix, use cohesive backfill conforming to Article 2.02.G.3, placed in 6-inch lifts. The cohesive backfill shall extend to the limits of the excavated area. Compact to not less than 90 percent of the maximum dry density as determined by ASTM D1557.

6. When shown on the Contract Drawings, flowable fill shall be used for backfilling of structures. Backfilling with flowable fill shall be as specified in Article 3.02.G.

7. When sheeting is withdrawn, solidly fill all cavities in or adjoining the trench or other excavation. When sheeting is left in place, solidly fill all cavities behind such sheeting.

J. Drainage Blanket

1. Provide a drainage blanket consisting of drainage fill where shown, specified, or required. Place drainage fill in uniform layers not greater than 8 inches in loose thickness.

2. Where drainage fill is required underneath structures or adjacent to structures where pipes, connections, electrical ducts and structural foundations will be located within the fill, compact the fill with suitable mechanical or pneumatic equipment to not less than 95 percent of the maximum dry density as determined by ASTM D1557.

3. Where drainage fill is required in areas not specified in Paragraph 3.02.J.2, compact with suitable mechanical or pneumatic equipment to not less than 90 percent of the maximum dry density as determined by ASTM D1557.

K. Earth Embankments

1. Make all earth embankments of approved cohesive common fill material.

2. Place fill in uniform layers not greater than 10 inches in loose thickness. Compact in place with suitable approved mechanical equipment.

3. Compact earth embankments to not less than 90 percent of the maximum dry density as determined by ASTM D1557.

4. Do not use cohesionless, granular material as earth embankment backfill, unless otherwise shown or required.

L. Finish Grading

1. Perform finish grading in accordance with the completed contour elevations and grades shown on the Contract Drawings and blend into conformation with remaining natural ground surfaces.

   a. Leave all finished grading surfaces smooth and firm to drain. Areas shall be finished to the degree obtainable by either blade or scraper operations and suitable for application of topsoil.

   b. Bring finish grades to elevations within plus or minus 0.10 foot of elevations or contours shown.

   c. Areas which are anticipated to be undisturbed for a period of more than 14 days shall be stabilized in accordance with the NYSDEC Blue Book, Section 31 25 10 – Dust Soil Erosion and Sediment Control and Section 32 90 00 - Planting.

2. Grade outside of building or structure lines in a manner to prevent accumulation of water within the area. Where necessary or where shown, extend finish grading to ensure that water will be carried to drainage ditches, and the site area left smooth and free from depressions holding water.

3.03 FIELD TESTING / QUALITY CONTROL

A. Sampling and Testing of Select, Common and Lightweight Backfill:

1. Provide sampling, testing, and laboratory methods in accordance with ASTM D1556 or other method as determined by the Engineer for select fill and common fill.

2. Lightweight fill shall be tested as specified herein.

3. Subject all backfill to these tests to the satisfaction of the Engineer. These tests shall be the basis for acceptance or rejection by the Engineer of the compaction. Failure to achieve the specified densities shall require the Contractor to recompact or remove the material as required.

B. Sampling and Testing of Flowable Fill:

1. The Contractor shall provide all facilities as may be necessary for the ready procurement of samples of flowable fill from the Work or truck mixers as required by the Engineer for test purposes.

2. The DEP/QA/QC Consultant will provide personnel and equipment for making periodic determinations in the field of slump, air content, ambient and concrete temperature, unit weight and yield and for the preparation of compressive strength test cylinders as required in compliance with applicable ASTM tests and procedures. In compliance with ASTM D4832,

a minimum of two cylinders will be tested at 7 days, two at 28 days, and three at 56 days. Tests shall be made on material at point of discharge into the Work. Tests shall be made for each 200 cubic yards of material placed but not less than one test for each day flowable fill is placed.

3. The Contractor shall supply all equipment necessary to perform the required tests including, but not limited to, cylinder molds, tags, capping compound, slump cones, platform scale, two buckets (each 2 cubic feet in size), thermometers, pressure air meter, and roller meter.

C. Correction of Work:

1. Correct any areas of unsatisfactory compaction by removal and replacement, or by scarifying, aerating or sprinkling as needed and recompaction in place prior to placement of a new lift. The Contractor shall, if necessary, increase the compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the lift thickness. The Contractor shall adjust the moisture content of the soil to bring it to the optimum range by drying or adding water, as required.

2. Correct any depression which may develop from settlement in backfilled areas within one year after the Work is fully completed. Provide, as needed, backfill material, pavement base replacement, permanent pavement, sidewalk, curb and driveway repair or replacement, and lawn replacement, and perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as approved.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

1.02 This Section describes the excavation and disposal of all material as specified here or shown on the Contract Drawings, for the purpose of building structures, conduits, pipe lines and other structures as well as grading and completing the work in every respect.

A. The following index of this Section is presented for convenience:

1.03 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.04 RELATED SECTIONS

A. Section 31 23 19 - Dewatering

B. Section 31 23 16 - Excavation

C. Section 31 70 20 - Controlled Blasting

1.05 REFERENCES

A. Definition

1. **"Rock"** shall include all materials requiring barring or wedging for their removal from their original beds and specifically includes all ledge or bed rock and boulders or masonry larger than one-half cubic yard in volume, but excludes pavements and pavement foundations.

1.06 DESCRIPTION

A. Not Used

1.07 QUALITY ASSURANCE

A. Not Used

1.08 SUBMITTALS

A. Before proceeding with any excavation work, obtain all necessary permits required by City and Town Departments having jurisdiction and all written consents from owners of private property affected by the prosecution of the work, which may necessitate temporary or permanent occupation, easements, storage of materials, or other physical encroachments.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.10 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.11 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Notification to Engineer to Measure Rock

1. Notify the Engineer before commencing Rock excavation. The Engineer will measure or cross-section the Rock. Rock removed before being measured or cross-sectioned will not be paid for.

3.02 IMPLEMENTATION

A. Shaping and Trimming

1. Make all excavations of adequate size to properly construct the structures in the manner and of the size specified and shown on the Contract Drawings, and to remove any material, which the Engineer may deem unsuitable for foundations. Whenever the nature of the ground will permit, form the bottom to the shape and dimensions of the outside of the masonry. In order to secure this shape, provide proper templates, firmly set and held to the proper line and grade.

B. Blasting

1. Blasting is allowed for excavation of bed rock. Section 31 70 20 – Controlled Blasting sets forth requirements for excavation by Controlled Blasting.

C. Prevention of Dust Hazard

1. Provide for the installation, maintenance and effective operation of appliances and methods for the elimination of harmful dust which have been approved by the Industrial Board of the Department of Labor of the State of New York, as provided in Section 222-a of the Labor Law. If the provisions of said Section 222-a are not complied, this Contract shall be void.

D. Over Breakage and Unauthorized Excavation

1. All overbreakage and unauthorized excavation carried outside the lines and grades given, except as hereinafter specified, together with the removal of the Excavated Materials or Rock, shall be at the Contractor's expense. Backfill unauthorized excavations as directed with compacted, suitable material, except for unauthorized excavations under structures, which shall be refilled with Class 20 concrete, unless otherwise permitted by the Engineer.

E. Additional Excavation

1. Excavate outside the established lines only when authorized in writing by the Engineer.

F. Sheeting, Bracing and Underpinning

1. Where required, support the sides of excavations with adequate sheeting and bracing. Where the character of rock, boulders or masonry in excavation is such as to render it necessary, closely drive the sheeting. Support structures requiring underpinning before the general excavation is started. Sheeting, underpinning and bracing shall conform to the requirements of Section 31 23 16 - Excavation.

G. Fencing, Bridging and Decking

1. Immediately enclose excavations in a public street, park or place, or in property adjoining the Site with a satisfactory guard fence. When a tight board fence is specified, no guard fence will be required, provided there is no delay in the erection of the tight board fence.

2. Where required for vehicular traffic, construct a substantial timber bridge, with side railings, across the excavation to permit the passage of vehicles.

3. Construct substantial temporary foot bridges, with side rails, wherever required by the Engineer.

4. At street intersections, provide substantial decking for traffic over excavations made from the surface. Maintain decking at all times except as hereinafter specified. The Contractor shall be fully responsible for the adequacy of the decking. Remove pavement and place decking during hours of day or night, which will cause the least inconvenience to adjoining property owners, to the public, and to traffic in general. During certain designated hours of the day or night, sections of planking not more than ten feet in length may be temporarily removed for the purpose of the excavating operations.

5. Obtain approval from the Engineer for designs for all fencing, bridging and decking before erection.

H. Removal of Water

1. At all times during the construction of the work and until final acceptance thereof, provide and maintain ample means and equipment with which to promptly remove and properly dispose of water and sewage entering the excavations or other parts of the work, and keep said excavations dry until the structures to be built therein are completed and backfilled to the level of ground water except where otherwise approved by the Engineer in writing. Dewatering and disposal of water shall conform to the requirements of Section 31 23 19 - Dewatering.

I. Reuse, Transport and Disposal of Excavated Rock Material

1. Reuse, transport and disposal of excavated Rock reuse shall conform to the requirements of Section 31 23 16 – Excavation.

2. Dispose of excavated Rock material not required or permitted to be used for backfilling in accordance with Section 31 23 16 - Excavation. Reuse of excavated Rock either on-site or off-site must be prioritized over disposal.

J. Sheeting Left in Place

1. Cut off at the elevations ordered all sheeting or bracing ordered in writing by the Engineer to be left in place in accordance with Section31 23 16 – Excavation. In general, such cut-offs shall not be less than 18 inches below the final ground surface. Do not remove sheeting without first securing the permission of the Engineer. Give particular attention to securing the stability of footings, which parallel and lie close to the excavation work.

2. The Contractor shall be fully responsible for injury to structures, property, or persons resulting from failure to leave in place sufficient sheeting and bracing.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 31 25 10 - DUST, SOIL EROSION AND SEDIMENT CONTROL
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, tools, equipment, and incidentals required to assure adequate environmental protection including implementation of all erosion and sediment control measures and maintenance of storage areas as directed by the Engineer.

B. The Contractor shall provide an Erosion and Sediment Control Plan (E&SCP) that establishes methods and procedures to prevent migration of contaminated stormwater and sediment and to prevent erosion of features of the Work.

C. The Contractor shall minimize erosion and prevent discharge of sediment to surface water features, watercourses, drainage systems, public streets or private property from construction activities. The Contractor shall provide methods to prevent construction activities from generating contaminated stormwater runoff. Methods of constructing berms and dikes to direct clean stormwater runoff around the work area to the local drainage system shall be included.

D. The Contractor shall comply with all Federal, State, or local laws, codes, ordinances, and regulations which govern the control of sediment, erosion, and stormwater during construction activities.

E. The Contractor shall provide Best Management Practices (BMPs) including, but not limited to silt fences, straw bales, diversion dikes, swales, sedimentation basins/traps, truck wash areas/decontamination stations, stabilized construction entrances and/or other means as a temporary structural practice to minimize erosion and sediment runoff.

F. The Contractor shall implement dust, erosion, and sediment control and stormwater pollution prevention in accordance with the requirements of the current NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity, and, if applicable, in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP) for this contract prepared by the Engineer.

G. DEP will provide the Contractor with a Storm Water Pollution Prevention Plan (SWPPP). If the Contractor's work plan requires any modification to the stormwater management elements outlined in the SWPPP, the Contractor shall be responsible for submitting a revised SWPPP to the Engineer for approval based on the construction sequencing, staging and means and methods to meet the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) General Permit requirements (GP-0-20-001, or latest version) and this Section and any additional requirements of the Municipal Separate Storm Sewer System (MS4) Community. Note that changes may require review and approval by the MS4.

H. The Contractor shall control dust caused by operation and movement of vehicles and equipment in accordance with the latest DEP and OSHA standards, and all other applicable Federal, State and local regulations.

I. The following index of this Section is presented for convenience:

J.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 74 17 - Cleaning and Site Maintenance

B. Section 02 24 20 - Soil Sampling and Analysis

C. Section 31 10 10 - Site Clearing

D. Section 31 23 19 - Dewatering

E. Section 31 23 16 - Excavation

F. Section 31 35 10 - Embankment and Channel Protection

G. Section 32 90 00 - Planting

1.04 REFERENCES

A. Comply with applicable provisions and recommendations of the following except as otherwise shown or specified.

1. NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-20-001, or latest version)
2. New York City Watershed Regulations (April 4, 2010, or latest version)
3. New York State Standards and Specifications for Erosion and Sediment Control (aka "Blue Book") (NYSDEC, November 2016, or latest version)
4. New York State Stormwater Management Design Manual (latest version)
5. New York State Department of Environmental Conservation (NYSDEC)
   a. 6NYCRR Part 361-4 – Mulch Processing Facilities.

1.05 DESCRIPTION

A. Definitions

1. Best Management Practices: Physical, structural, and/or managerial practices that, when used singly or in combination, prevent or reduce pollution of water, and have been approved by DEP or NYSDEC.
2. Commencement of Construction: The initial disturbance of soils associated with clearing, grading or excavation activities; or other construction related activities that disturb or expose soils such as demolition, stockpiling of fill material, and the initial installation of erosion and sediment control practices.
3. Erosion: The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as geological creep, detachment, movement of soil or rock fragments by water, wind, ice, or gravity.
4. Erosion/Sediment Control: Any temporary or permanent measures taken to reduce erosion, control siltation and sediment, and ensure that sediment-laden water does not leave the site.
5. Final Stabilization: All soil-disturbing activities at the site have been completed and uniform, perennial vegetative cover with the density of eighty (80) percent has been established or equivalent stabilization measures (such as the use of mulches or geo-textiles) have been employed on all unpaved areas and areas not covered by permanent structures, concrete or pavement.
   a. Vegetative cover stabilization shall employ a Meadow Mix as per Section 32 90 00 – Planting.

6. Receiving Waters: Bodies of water or surface water systems receiving water from upstream manmade (or natural) streams

7. Sediment: Fragmented material that originates from weathering and erosion of rocks and unsolicited deposits, and is transported by, suspended in, or deposited in water.

8. Trained Contractor: A person who is responsible for the day to day implementation of the SWPPP and who has received four (4) hours of NYSDEC endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District or other NYSDEC endorsed entity.

9. Qualified Inspector: A person knowledgeable in the principles and practice of erosion and sediment controls meeting either of the below conditions:

   a. A licensed NYS Professional Engineer; licensed Landscape Architect with documented training and education in the principles and practices of ESC.

   b. An individual certified in ESC by CPESC, Incorporated or any other agency endorsed by the NYS Department of Environmental Conservation Office of Water Resources.

   c. An individual working under the direct supervision of a qualified licensed Professional Engineer or qualified licensed Landscape Architect with documented training and education in the principles and practices of ESC and has completed the four (4) hour training program in the principles and practices of erosion and sediment control from either a Soil and Water Conservation District, CPESC or any other agency endorsed by the NYS Department of Environmental Conservation Office of Water Resources.

   d. Any other individual endorsed by the NYS Department of Environmental Conservation by written documentation.

B. Environmental Requirements

1. Soil Stabilization: The stabilization practices to be implemented shall include one or a combination of the following: temporary seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, erosion control mats, protection of trees and shrubs, preservation of mature vegetation. Protection of trees shall be in accordance with Section 31 10 10 – Site Clearing. Stabilization practices shall be implemented as approved by the Engineer. Seeding and planting shall be in accordance with Section 32 90 00-Planting. The Contractor shall record the dates when the major grading activities occur (i.e. clearing and grubbing, excavation, embankment and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs 1.08A.1 and 1.08A.2 below,

stabilization practices shall be initiated as soon as practicable, but no more than fourteen (14) days after construction activities have temporarily or permanently ceased.

a. Unsuitable Conditions: Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases is precluded by unsuitable conditions caused by the weather. Stabilization practices shall be initiated as soon as practicable after conditions become suitable.

b. Non-winter month Temporary Inactivity Less than 14 Days: Where construction activity will resume on a portion of the site within 14 days after it temporarily ceases, no stabilization practices will be required.

c. Winter months Temporary Inactivity Less than 3 Days: In winter months, where construction activity will resume on a portion of the site within 3 days after it temporarily ceases, no stabilization practices will be required.

2. Erosion and Sediment Control: Erosion and Sediment control BMPs shall be operational at all times during the Work, specifically during excavation, backfilling and restoration, and decontamination operations. The sediment and erosion control system shall be capable of handling stormwater during construction. Damage to excavation slopes and the migration of contaminated soil to downstream areas resulting from storm events shall be repaired or remediated by the Contractor, at the Contractor's expense.

3. Stormwater: At no time shall the Contractor allow effluent from decontamination operations to migrate off to contaminate soils in other areas or percolate into the groundwater. The Engineer will monitor any overflow or leakage that occurs, and may at his discretion require the Contractor to perform soil sampling within all areas affected by such overflow. Any soils that have been contaminated by such overflow shall be removed, treated and disposed of by the Contractor at no additional cost to the City. All sampling and analyses of soils required to determine the contamination or remediation of these soils shall be performed in accordance with Section 02 24 20 – Soil Sampling and Analysis.

4. Disposal of Water: Water collected from decontamination areas and dewatering operations shall be handled in accordance with Section 31 23 19 - Dewatering.

5. Concrete Washout Debris: Concrete washout muck and debris shall be removed and adequately disposed by the Contractor at no additional cost to the City.

C. Project Conditions

1. Existing Work: All BMPS (e.g., silt fences, straw bales, swales, sumps, pumps, piping) and other sediment/stormwater controls shall be installed such that other aspects of the Work are not adversely impacted or endangered. All installations shall be subject to the approval of the Engineer.

2. Dust Control: The Contractor shall be responsible for controlling visible dust caused by Work operations and the moving of vehicles and equipment. Dust control shall be implemented when soils are exposed, before, during and after Work activity ceases. Dust control will also be required on the weekends. The Contractor shall utilize the application of water or other methods, subject to the Engineer's approval, when visible dust is present on-site, in accordance with the Health and Safety Plan. The use of chemicals for dust control, including calcium chloride, will not be permitted.

    a. All excavation, loading and transport of materials shall minimize the formation of dust and shall conform to Section 31 23 16 - Excavation. To prevent dust generation, application of water to roadways and active work areas shall be utilized as required. The Contractor's operations shall include air monitoring and dust minimization measures, consistent with the Health and Safety Plan (HASP) Specifications.

3. Silt and Sediment Disposal: All silt and sediment which accumulates behind any BMPs used on the site (i.e., straw bale berms or silt fences) shall be removed and disposed of off-site in accordance with all applicable Federal, State and local regulations.

D. Materials

1. All components/controls must be designed in conformance with the most current version of the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, and the New York State Stormwater Management Design Manual. Where erosion and sediment control practices are not designed in conformance with these technical standards, the Contractor must submit modified practices as part of the Contractor's Erosion and Sediment Control Plan, demonstrate equivalence to the technical standard, obtain the Engineer's approval and update the project SWPPP accordingly.

E. Installation and Maintenance

1. All installation of erosion and sediment control BMPs must be consistent with the most current version of the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, and the New York State Stormwater Management Design Manual. Where erosion and sediment control practices are not designed in conformance with these technical standards, the Contractor must submit modified practices as part

of the Contractor's Erosion and Sediment Control Plan, demonstrate equivalence to the technical standard, obtain the Engineer's approval and update the project SWPPP accordingly.

2. Maintenance: The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition at all times consistent with the most current version of the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, and the New York State Stormwater Management Design Manual.

1.06 QUALITY ASSURANCE

A. Permits and Regulations:

1. The Contractor shall obtain all necessary permits and be responsible for implementing the terms and requirements of these permits as needed and for payment of all fees.

2. The Contractor shall handle all material in compliance with applicable requirements of OSHA and other governing authorities having jurisdiction.

3. Certifications. The Contractor must sign a copy of the certification statements below, as provided in GP-0-20-001 (or certifications in latest version), before undertaking any construction activity at the site identified in the SWPPP. All certifications must be included in the SWPPP.

a. "I hereby certify that I understand and agree to comply with the terms and conditions of the SWPPP and agree to implement any corrective actions identified by the qualified inspector during a site inspection. I also understand that the NYCDEP must comply with the terms and conditions of the New York State Pollutant Discharge Elimination System ("SPDES") General Permit for Stormwater Discharges from Construction Activity (GP-0-20-001, or latest version) and that it is unlawful for any person to cause or contribute to a violation of water quality standards. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings."

b. The certification statements must include the name and title of the person providing the signature, address and telephone number of the contracting firm, the address of the site, and the date the certification is made. The certification must be signed by an authorized representative of the firm.

4. Inspections.

a. Maintenance Inspections: A Trained Contractor shall inspect the erosion and sediment control practices and pollution measures being implemented within the active work area daily to ensure that they are always being maintained in effective operating conditions. If deficiencies are identified, the Contractor shall begin implementing corrective actions within one business day and shall complete the corrective actions in a reasonable time frame.

b. Qualified Inspector Site Inspections: The Contractor shall coordinate inspections with the Construction Manager's Qualified Inspector. Qualified Inspector Site inspections are conducted a minimum of twice every seven (7) calendar days. The two (2) inspections shall be separated by a minimum of two (2) full calendar days. The Contractor shall begin implementing any corrective actions identified by the Qualified Inspector within one business day and shall complete the corrective actions in a reasonable time frame.

c. Inspection reports shall be maintained in a logbook at the site with SWPPP and other required documentation.

5. Stabilization. The contractor shall initiate stabilization measures as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased.

6. The SWPPP shall be kept current on file at the construction site for review by a NYSDEC inspector. If there is a significant change in construction which may have a significant effect on the potential for the discharge of pollutants to surface waters of the State and which has not otherwise been addressed in the SWPPP, it would require that the SWPPP be updated to reflect those required changes. The SWPPP would also require an amendment if the SWPPP proves to be ineffective in eliminating or significantly minimizing pollutants from sources identified in the SWPPP or achieving the general objectives of controlling pollutants in stormwater discharges from permitted construction activity. Additionally, the SWPPP shall be amended to identify any new subcontractor and their associated responsibilities.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and other documentation, required to show conformance to the requirements of the Contract Drawings, for the approval to the Engineer. Shop Drawings shall show details of the Sediment and Stormwater Control System. The Submittals shall include, but not limited to the following:

1. Plan locations of all components of the Sediment/Stormwater Control System.

2. Details of all applicable BMPs (e.g., silt fence, diversion dike, straw bale berm, decontamination stations, etc.).

3. All of the planned components of the Erosion and Sediment Control Plan, as detailed below in Paragraph B.

4. All components of the SWPPP to be constructed on site, as detailed in Paragraph C below.

5. The Contractor shall submit manufacturer's descriptive literature and installation instructions for stockpile liner and cover material as specified in Paragraph 2.01.B and Part 3.02.

B. Erosion and Sediment Control Plan (E&SCP): The Contractor shall develop and submit to the Engineer for approval, prior to commencement of construction activities, an E&SCP. The E&SCP shall address schedules and measures that will be taken to prevent migration of contaminated stormwater/sediment, and to prevent erosion of features of the Work. The E&SCP shall include the following at a minimum:

1. Measures to capture and mitigate stormwater runoff from active, disturbed areas.

2. Provisions for silt fences and other measures to limit migration of sediments.

3. Provisions for straw bale berms and silt fences or other measures to prevent contaminant and sediment migration.

4. Diversion of stormwater: The Contractor shall include provisions for controlling stormwater runoff in and around excavation areas.

5. Soil Storage Area: All details of temporary soil storage to be implemented as specified in this section.

6. Soil Stabilization Practices: All details of soil stabilization practices to be implemented, as specified in this section.

7. Culvert inlet, culvert outlet and channel protection in accordance with section 31 35 10 – Embankment and Channel Protection.

8. Provisions for all other applicable Best Management Practices.

C. The Contractor shall adopt the SWPPP prepared by the Engineer for this Contract. If the Contractor proposes to modify the SWPPP, the Contractor shall develop and submit to the Engineer for approval the modified SWPPP in accordance with the requirements of the current NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity. The modified SWPPP shall be developed and submitted to the Engineer for approval prior to the initiation of construction activities. The modified SWPPP must be in compliance with the requirements of this Section in all respects. The Contractor shall bear sole responsibility for all permitting requirements of, and coordination with, the governing authorities having jurisdiction, as well as for any costs and delays resulting from the modification(s).

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall store, handle, and remove material and equipment consistent with requirements of the SWPPP and NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (Permit No. GP-0-20-001) or latest version.

B. Removal of all waste shall be in accordance with the requirements of Section 01 74 20 – Construction Waste Management.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Materials

1. Stockpile cover and liner fabric shall be a composite structure of fiber-reinforced polyethylene (RPE) fabric (minimum 20-mils). The fabric shall be inert to biological degradation and naturally encountered chemicals, alkalis and acids. Its permeability coefficient shall be less than 10^{-3} cm/sec.

2. Erosion Control Blanket shall be a type of rolled erosion control product that is fully biodegradable with a functional longevity of a minimum of twenty-four (24) months. It shall be comprised of weed- and pest-free wood fiber or straw, or combination thereof, at a minimum unit weight of 10 ounces per square yard and a triple netted layer of biodegradable material. Staples shall be used to anchor the blanket to the bare soil surface.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. Stockpiling

1. Cover and Liner Requirements

a. Soil Stockpiles: Stockpiles of excavated soil to be used for backfilling on-site under the NYSDEC Pre-Determined or Case-Specific BUD, or stockpiles of other soil mixes being brought onsite for landscaping purposes, shall be stored as follows:

1) Contaminated Soil: Stockpiles of excavated soil that are known to be or potentially could be contaminated (pending analysis), shall be lined on the bottom and covered with an impermeable, RPE fabric, as specified in 2.02.A above.

2) Uncontaminated Soil: Stockpiles of excavated uncontaminated soil shall have a cover only; a bottom liner is not required. The cover fabric shall be as specified in 2.01.B above.

3) Delaware Aerator Topsoil Pile: Delaware Aerator Topsoil pile, as shown in contract drawings, shall be stabilized in accordance with the NYSDEC Blue Book; a bottom liner is not required.

b. Demolition Waste Stockpiles: Stockpiles of demolition waste that are to be recycled (on-site or off-site) or disposed of at a sanitary landfill shall be stored as follows:

1) Contaminated Demolition Waste: Stockpiles of demolition waste that are known to be or potentially could be contaminated (pending analysis), shall be lined on the bottom and covered with an impermeable, RFP fabric, as specified in 2.01.A above.

2) Uncontaminated Demolition Waste: Stockpiles of uncontaminated demolition waste shall have a cover only; a bottom liner is not required. The cover fabric shall be as specified in 2.01.A above.

c. Stockpiles of materials classified as contaminated, hazardous waste shall be stored with a cover and liner as specified above for contaminated soil or contaminated demolition waste, and transported off-site promptly in DOT-approved hazardous waste shipping containers. Temporary hazardous waste storage areas shall

comply with and the requirements of the Contract and applicable Federal, State and local regulations.

d. All stockpiles shall be covered during non-working hours and during periods of no construction activity. The terminal edges of the fabric cover panels shall be secured to prevent uplift by wind.

2. Stockpile Areas and Placement

a. Stockpiling of excavated materials will be permitted on-site within areas as designated on the Contract Drawings for construction staging, or as directed by the Engineer. All stockpiling areas on-site must be approved by the Engineer in advance.

b. The Contractor shall make his or her own arrangements to provide additional stockpiling area on-site or off-site, if required, for excavated material at no additional cost to the City. Additional stockpiling areas whether on-site or off-site shall be approved by the Engineer.

c. Stockpiles of excavated material to be used for backfilling on-site under the NYSDEC Pre-Determined or Case-Specific BUD shall be so piled and placed as not to encumber sidewalks or roadways, or wash away or obstruct the free flow of surface or drainage water. Stockpiles shall be suitably bermed for run-off containment of any water that drains from the soils.

d. Stockpiles shall not be placed closer to the edge of an excavation than a distance equal to 1-1/2 times the depth of the excavation, unless the excavation is in rock or the sides of the excavation have been sloped or sheeted and shored to withstand the lateral forces imposed by such superimposed loads.

B. The contractor shall provide winter stabilization in accordance with Section 2.38 of the NYS Standards and Specifications for Erosion and Sediment Control (Blue Book). The winter stabilization standards apply to all construction activities involved with ongoing land disturbances and exposure between November 15th to the following April 1st. The contractor shall provide the following:

1. Snow Management Plan
2. 25 ft. perimeter buffers
3. Tall marker stakes for silt fence
4. 2 rows of silt fence if within 100ft. of a waterbody
5. Clear flow paths to drainage structures
6. Soil stockpiles shall be stabilized
7. Soil stabilization performed daily

8. Provide 2x normal mulching rate

C. The contractor shall not chip existing felled trees onsite. The contractor shall sell the merchantable wood and purchase wood mulch.

1. Wood Mulch shall be in accordance with NYS Erosion and Sediment Control Standards and the Landscaping Plans.

2. Purchased wood mulch shall be used for winter stabilization.

D.

3.03 FIELD TESTING / QUALITY CONTROL

A. Inspection of soil and material stockpiles shall be done daily to ensure the integrity of the cover and liner is maintained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. The Contractor shall clean the site and equipment consistent with requirements of the SWPPP , the current New York State Standards and Specifications for Erosion and Sediment Control and Section 01 74 17 - Cleaning and Site Maintenance. Where appropriate, truck wash/decontamination stations shall be installed to minimize the migration of sediment off-site as specified herein**.**

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for furnishing and placing a protective covering of erosion-resistant material on embankment slopes, streambanks, at culvert inlets or outlets, on bottoms and side slopes of channels, at structure foundations, and at other locations shown on the Contract Drawings or as directed by the Engineer. The work shall be done in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical sections shown on the Contract Drawings or established by the Engineer.

B. Embankment and channel protection includes stone filling, dry riprap, grouted riprap, concrete block paving, gabions and bedding material for stone.

C. This Section is based on Section 620 of the New York State Department of Transportation (NYSDOT) Standard Specifications.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 31 10 10 - Site Clearing

B. Section 31 23 16 - Excavation

C. Section 31 23 23 - Fill

D. Section 31 25 10 - Dust, Soil Erosion and Sediment Control

1.04 REFERENCES

A. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium

B. ASTM C140 - Standard Test Methods for Sampling and testing Concrete Masonry Units and Related Units

C. ASTM C150 - Standard Specification for Portland Cement

D. ASTM A974 – Standard Specification for Welded Wire Fabric Gabions and Gabion Mattresses

E. ASTM A975 – Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses

F. American Association of State Highway and Transportation Officials (AASHTO) Standards

G. New York State Department of Transportation (NYSDOT) Standard Specifications

H. NYSDOT Materials Bureau, Materials Method 29

I. NYSDOT Section 620 (Bank and Channel Protection)

1.05 DESCRIPTION

A. Definitions

1. Stone Filling: Stone Filling shall consist of well-graded stone placed as protective material on earth embankments, on streambanks, in channels and elsewhere, as shown, specified or required.

2. Dry Riprap: Dry Riprap shall consist of stone fitted and placed on streambanks or in channels in order to provide protection against erosion.

3. Grouted Riprap: Grouted Riprap shall consist of stone similar to dry riprap but with all spaces between the stones filled with cement grout.

4. Bedding Material. Bedding Material shall consist of granular material placed in a layer, where required, on the ground surface prior to placing stone filling or riprap. The purpose of the bedding material is to prevent underlying finer materials from passing into and through the stone filling or riprap.

5. Concrete Block Paving: Concrete Block Paving shall consist of concrete blocks placed on embankment slopes under structures as protection against erosion.

6. Cushion Sand: Cushion Sand shall consist of fine aggregate placed on the ground prior to placing concrete block paving.

7. Gabions: Gabions shall consist of open wire mesh baskets, filled with stones.

1.06 QUALITY ASSURANCE

A. The soundness of all material used for stone filling, riprap, fine aggregate and gabion stones shall be approved on the basis of it satisfying the following criteria:

1. Stone Filling and Riprap:

a. Freeze-Thaw Test: A maximum 10 percent loss, by weight, after 25 cycles of freezing and thawing. Test shall be performed in accordance with NYSDOT Materials Bureau, Materials Method 29, Test Method No. 703-08 P,G.

b. Magnesium Sulfate Soundness Test: A maximum 10 percent loss by weight, after 10 cycles of the magnesium sulfate soundness test. Test shall be performed in accordance with ASTM C88 and NYSDOT Materials Bureau, Materials Method 29, Test Method No. 703-07 P,G.

2. Fine Aggregate:

a. Magnesium Sulfate Soundness Test: A maximum 30 percent loss, by weight, after 5 cycles of the magnesium sulfate soundness test performed in accordance with ASTM C88 and NYSDOT Materials Bureau, Materials Method 29, Test Method No. 703-06 P,G.

b. Organic Impurities Test performed in accordance with NYSDOT Materials Bureau, Materials Method 29, Test Method No. 703-03 P,G and AASHTO T-21 shall result in Organic Plate lighter than 3 and Gardner Color lighter than 11.

1.07 SUBMITTALS

A. Certified laboratory reports showing the following, as applicable:

1. Stone filling or riprap meets the criteria of the freeze thaw test and the magnesium sulfate soundness test requirements specified herein in the subsection headed "Quality Assurance."

2. Bedding material conforms to gradation requirements.

3. Grout sand conforms to gradation requirements for grout for grouting riprap or grout for concrete block paving, as applicable.

4. Cushion sand for concrete block paving conforms to gradation requirements.

5. Gabion wire mesh, tie wire and stone meet the specified material requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Stone Filling

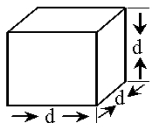
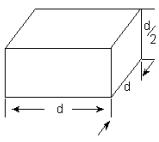
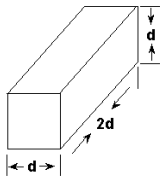
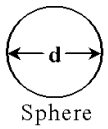
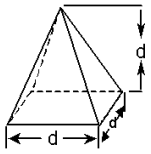
1. The gradation of materials furnished for use as stone filling shall be as specified below, and will be accepted or rejected based on a visual examination of the material by the Engineer.

STONE FILLING GRADATION REQUIREMENTS			
Stone Filling Item	See Notes Below	Stone Size[1]	Percent of Total by Weight
Fine	2, 3, 4	Smaller than 8 inches Larger than 3 inches Smaller than No. 10 Sieve	90 - 100 50 - 100 0 - 10
Light	2, 3, 4	Lighter than 100 lbs. Larger than 6 inches Smaller than ½ inch	90 - 100 50 - 100 0 – 10
Medium	2, 4	Heavier than 100 lbs. Smaller than 4 inches	50 - 100 0 – 10
Heavy	2, 4, 5	Heavier than 600 lbs. Smaller than 6 inches	50 - 100 0 – 10

NOTES:
1. Stone sizes, other than weights, refer to the average of the maximum and minimum dimensions of a stone particle as estimated by the Engineer.
2. Materials shall contain less than 20 percent of stones with a ratio of maximum to minimum dimension greater than three.
3. Air-cooled blast furnace slag, cobbles or gravel having at least one fractured face per particle are acceptable substitutes for stone under these items, provided that soundness and gradation requirements are met.
   Materials shall contain a sufficient amount of stones smaller than the average stone size to fill the spaces between the larger stones.

2. The following table is provided to assist the Contractor and the Engineer in evaluating the gradation of materials considered for use as Stone Filling or Riprap.

CORRELATION OF STONE WEIGHTS AND DIMENSIONS

SPECIFIED WEIGHTS AND SIZES	APPROXIMATE SHAPE				
				 Sphere	
600 lbs	d = 18 ins.	d = 23 ins.	d = 15 ins.	d = 23 ins.	d = 27 ins.
300 lbs.	d = 15 ins.	d = 18 ins.	d = 12 ins.	d = 18 ins.	d = 21 ins.
150 lbs.	d = 12 ins.	d = 15 ins.	d = 9 ins.	d = 15 ins.	d = 17 ins.
100 lbs.	d = 10 ins.	D = 13 INS.	d = 8 ins.	d = 13 ins.	d = 15 ins.
d = 8 ins.	50 lbs.	25 lbs.	100 lbs.	25 lbs.	16 lbs.
d = 6 ins.	20 lbs.	10 lbs.	40 lbs.	10 lbs.	7 lbs.

B. Dry Rip Rap.

1. Dry riprap shall consist of stones shaped as nearly as practicable in the form of right rectangular prisms. Stones shall be graded in size to produce a

reasonably dense mass. Riprap shall consist of dense, natural rock fragments. Stones shall be resistant to weathering and to water action; free from overburden, spoils, shale, and organic material; and shall meet the gradation requirements below. Shale and stones with shale seams are not acceptable. One dimension of each of the stones furnished shall be at least equal to the thickness of the rip-rap as shown on the Drawings.

2. Rip-rap shall conform to the size types as follows:

a. Type I (6-inch average size):

Diameter	Percentage Passing
12 inch	95–100
6 inch	25–75
3 inch	0–10

b. Type II (12 inch average size):

Diameter	Percentage Passing
18 inch	95–100
12 inch	25–75
6 inch	0–5

c. Type III (18 inch average size):

Diameter	Percentage Passing
24 inch	95–100
18 inch	25–75
13 inch	0–5

d. Type IV (24 inch average size):

Diameter	Percentage Passing
30 inch	95–100
24 inch	25–75
18 inch	15–25
12 inch	0–5

C. Grouted Riprap. The requirements for the stone used for grouted riprap shall be the same as specified for Dry Riprap. The grout shall consist of one part cement conforming to the requirements of ASTM C150 for Portland Cement Type II, and three parts of fine aggregate, conforming to the requirements for fine aggregate set forth in the subsection headed "Quality Assurance." When dry, the fine aggregate shall conform to the following gradation requirements:

Sieve Size	Percent Passing by Weight	
	Minimum	Maximum
3/8 inch	100	--
No. 4	90	100
No. 8	75	100
No. 16	50	85
No. 30	25	60
No. 50	10	30
No. 100	1	10
No. 200 (Wet)	0	3

D. Bedding Material: Bedding material shall be composted of crushed stone, crushed air-cooled blast furnace slab, or gravel, free of soft, non-durable particles, organic material, and thin or elongated particles. Bedding material shall meet the following gradation requirements:

Sieve Designation	Percent by Weight Passing
4 in.	100
1 in.	15 to 60
1/4 in.	0 to 25
No. 40	0 to 10

E. Concrete Block Paving

1. The concrete blocks shall be designed to have a compressive strength of 2,500 psi, and shall have the following minimum dimensions:

Length:	Thickness:	Width:
16 to 20 inches	6 inches (solid)	8 inches

2. The standard dimensions of the block shall be the specified nominal dimensions minus 3/8 of an inch. The maximum permissible variation in dimensions of individual units from standard dimensions shall be no more than 1/8 inch. The size of block used shall be consistent throughout any

continuously paved area, and only one nominal length shall be used in any contract. All units shall be sound and free from cracks or other defects that would interfere with the proper placing of the blocks or impair the strength, permanence and appearance of the construction.

3. Sampling and Testing

a. Sampling: Samples of the block will be selected by the Engineer from production lot quantities in accordance with the following:

Lot Size (Number of Units)	Number of Samples
0 - 10,000	6
10,001 - 99,999	12
100,000 - 150,000	18
For each additional 50,000 or fraction thereof	6 additional samples

b. In no case will less than 6 blocks be selected as samples. Additional specimens may be required at the discretion of the Engineer. Samples may be taken at the manufacturing plant or at the job site, at the option of the Engineer.

c. Testing

1) The minimum average compressive strength of concrete paving block samples shall be 2500 pounds per square inch. This strength shall be determined on full size block samples, by load application in a direction parallel to the slope upon which the block is to be placed. The compressive strength of any individual unit shall be not less than 2000 pounds per square inch.

2) The maximum average absorption of concrete paving block samples representing any lot shall not exceed 10 percent by weight. The absorption of any individual unit shall not exceed 12 percent by weight.

3) All test procedures shall be in accordance with ASTM C140.

F. Cushion Sand

1. Cushion sand for concrete block paving shall consist of clean, hard, durable, uncoated particles, free from lumps of clay and all deleterious substances. When dry, the cushion sand shall meet the following gradation requirements:

Sieve Size	Percent by Weight Passing
1/4 in.	100
No. 50	0 - 35
No. 100	0 - 10

2. The sand will not be approved for cushion sand if it contains more than 10 percent by volume of loam or silt. The cushion sand will be accepted on the basis of gradation tests and visual inspection at the point of use.

3. Grout, where used, shall consist of one part cement conforming to the requirements of ASTM C150 for Portland Cement Type II, and two parts fine aggregate, conforming to the requirements for fine aggregate set forth in the subsection headed "Quality Assurance." When dry, the fine aggregate shall conform to the following gradation requirements:

Sieve Size	Percent by Weight Passing
No. 4	100
No. 8	95 - 100
No. 50	10 - 40
No. 100	0 - 15

4. As an alternative, the fine aggregate may be the same as that specified above for grouting riprap.

G. Gabions

1. Gabions shall be constructed with galvanized wire with coating of polyvinyl chloride (PVC) as shown on the Contract Documents. The wire mesh, tie wire, basket construction, and stone fill shall meet the material requirements set forth in Section 712-15, Gabions, of the NYSDOT Standard Specifications. Gabions produced from twisted wire shall conform to the requirements of ASTM A975. Gabions produced from welded wire shall conform to the requirements of ASTM A974. Test reports on the wire and stone shall be conducted and certified by a testing facility approved by the City.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. General:

1. The ground surface on which bank or channel protection is to be placed shall be free of brush, trees, stumps, and other objectionable material and shall be dressed to a smooth surface in accordance with Section 31 10 10 – Site Clearing. All soft or spongy material shall be removed to the depth shown on the Contract Drawings or as directed by the Engineer and replaced with approved material. Excavation shall be in conformance with Section 31 23 16 - Excavation. Filled areas shall be compacted in accordance with applicable provisions of Section 31 23 23 - Fill. Dust, soil erosion and sedimentation control measures shall be performed in accordance with Section 31 25 10 – Dust, Soil Erosion and Sedimentation Control. Protection for structure foundations shall be in accordance with Section 01 71 30 – Protection and Restoration of Structures and shall be provided as early as the foundation construction permits.

B. Stone Filling

1. Stone filling shall be placed in a manner that will produce a reasonable well-graded mass of stone with smaller stone fragments filling the space between the larger ones, so as to result in the minimum practicable percentage of voids. The final section of stone filling shall be in conformance with the lines, grades and thicknesses shown on the Contract Drawings. Stone filling used for bank or channel protection shall be placed to its full course thickness in one operation, unless otherwise directed by the Engineer or specified in the Contract Documents, and in such a manner that the underlying material will not be displaced or worked into the layer of stone filling. Placement of stone upon finished bedding material, when used, shall be carefully controlled to avoid disruption and damage to the layer of bedding material. The stone shall be so placed and distributed that there will be no pockets of uniform size material.

2. The desired distribution of the various sizes of stone throughout the mass shall be obtained by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing; or

by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand shall be done to the extent necessary to secure the specified results. When stone filling is dumped under water, methods shall be used that will minimize segregation.

C. Dry Riprap

1. The stones shall be placed so that the dimension approximately equal to the layer thickness is perpendicular to the slope surface and that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest stones shall be placed at the bottom of the slope. The dry riprap shall be properly aligned and placed so as to minimize void spaces between adjacent stones. The spaces between the stones shall be filled with spalls of suitable size.

D. Grouted Riprap

1. The procedure of placing the stones shall be the same as described in Paragraph 3.01C for Dry Riprap, except that the space between the stones shall be filled with grout rather than spalls. Material upon which the grouted riprap is laid shall not be allowed to occupy the space between the stones.

2. When the stones are in place, the spaces between them shall be completely filled with grout and the surface of the stones cleaned to remove accumulations of grout. Riprap shall not be grouted in freezing weather. The grouted riprap shall be kept moist for seven days after grouting. A suitable curing compound may be employed, if approved by the Engineer.

3. The Engineer may direct that occasional spaces be left ungrouted for relief of hydrostatic pressure. The ungrouted spaces shall be chinked with spalls of suitable size.

E. Bedding Material

1. When specified in the Contract Documents or directed by the Engineer, stone filling and dry riprap shall be placed on bedding material. The bedding material shall be placed on the prepared area to the full specified thickness of each layer in one operation, using methods which will not cause segregation of particles sizes.

2. Contamination of bedding material by natural soils or other materials shall be prevented at all times. Bedding material that becomes contaminated shall be removed and replaced with uncontaminated bedding material at no expense to the City.

F. Concrete Block Paving

1. Blocks shall be laid on a 3-inch bed of cushion sand in running bond with the long dimension transverse to the slope and all joints tight. Blocks shall

be thoroughly rammed in place to provide a uniformly even surface and solid bedding under each block.

2. In the areas where grouting is called for, the concrete block shall be laid in running bond with the length parallel to the slope and with 1/4" joints. Following the laying of blocks, in the area to be grouted, sufficient sand of the same gradation as that used in the grout shall be spread over the surface and swept into the joints to fill the joints to four inches from the surface. The block shall be wetted to the satisfaction of the Engineer before any grout is placed. The joints shall be filled with grout from the bottom flush with the top of the block.

3. After grouting has been completed and the grout has sufficiently hardened, the blocks shall be wetted, covered and cured with curing covers for the first seven days after grouting. Grout shall not be poured during freezing weather.

G. Gabions

1. Each gabion unit shall be assembled by binding together all vertical edges with wire ties on approximately six-inch spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil about every four inches. Empty gabion units shall be set to line and grade as shown on the Contract Drawings. For structural integrity, wire ties or connecting wire shall be used to join the gabions together along the perimeter of all contact surfaces according to the manufacturer's instructions. Internal tie wires shall be uniformly spaced and securely fastened in each outside cell of the structure in accordance with the manufacturer's instructions or where ordered by the Engineer. When gabions are being placed as slope protection, the cross-connecting wire may be deleted if ordered by the Engineer.

2. A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

3. The gabions shall be filled with stone carefully placed by hand or machine to assure alignment and avoid bulges with a minimum of voids. After a gabion has been filled, the lid shall be bent over until it meets the side and edges. The lid shall then be secured to the sides, ends and diaphragms with the wire ties or connective wire in the same manner as described above for assembling.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Provide all labor, equipment, tools, materials and incidentals, and perform all design and operations necessary for the Controlled Blasting Work complying with all rules and regulations of all AHJs, including the Town of Mount Pleasant Code (including blasting requirements from the Town of Greenburgh Code), Federal, State and as specified in this Section, as shown on the Contract Drawings and as approved, for the excavation in rock for site grading at Kensico.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 01 14 00 – Work Restrictions

B. Section 01 41 00 – Regulatory Requirements

C. Section 01 43 05 – Contractor's Work Quality

D. Section 31 09 00 – Geotechnical Instrumentation and Monitoring

E. Section 31 23 25 – Rock Excavation

1.04 REFERENCES

A. Definitions:

1. Air-Overpressure (Airblast): Fluctuating changes in ambient air pressure caused by blasting. Air-overpressure is expressed in units of linear-scale decibels (dB). Microphones that measure blast-induced Air-overpressure have flat Frequency response from 2 to 250 Hertz.

2. Blaster-in-Charge: The trained and qualified person(s) in charge and responsible for all matters regarding the safe use of explosive materials once they are received from the Magazine Keeper. The Blaster-in-Charge is also responsible for filling out necessary explosive use or blasting report forms, and is responsible for returning all unused explosive materials to the Magazine Keeper. Blaster-in-Charge shall supervise the work being performed by blasters, drillers, and helpers.

3. Blasting Consultant: The qualified specialist having qualifications and work experience requirements stipulated in this Section. The Blasting Consultant shall be in charge of and responsible for preparation of Controlled Blasting designs and plans, test-blasting plans, review and provide revisions to any of these plans, and provide recommendations on blast-effect control measures.

4. Buffer Holes: Holes with reduced energy charges drilled adjacent to smoothwall holes or line-drilled holes at the perimeter of the excavation. The explosive charge in Buffer Holes is generally between 50 and 75 percent of the charge used in normal production blastholes. Buffer Holes are usually drilled parallel to adjacent holes at the excavation perimeter.

5. Burden/Spacing Ratio: The ratio value calculated to evaluate the effectiveness of smoothwall blast designs. The ratio value is determined by dividing the burden (distance between smoothwall perimeter holes and the first-row-in blastholes) by the spacing distance between perimeter holes.

6. Controlled Blasting: Special blasting methods used to limit the effects of blasting to within the final lines and grades of an excavation, and to regulate charges of explosives detonated simultaneously, to control Peak Particle Velocities, noise levels, and Air-Overpressure to limits allowed for specific locations.

7. Fly Rock: Debris that is ejected or propelled through air by blast.

8. Frequency: Ground vibration oscillation at peak event, expressed in Hertz.

9. Geophone: An electronic vibration sensor designed to measure ground vibrations in the three orthogonal directions on or below ground surface and to convert them into electric impulses that are proportional to the displacement, velocity, and acceleration of ground movement.

10. Green Concrete: Concrete newly poured that has undergone final setting but has not hardened to design strength. It also includes shotcrete.

11. Line Drilling: A method of controlling overbreak and reducing ground-borne vibration energy transfer, in which a series of very closely spaced holes are drilled at the perimeter of the excavation. Line holes are generally not loaded with explosives; however, in some applications alternating holes may be loaded with light charges.

12. Magazine Keeper: The person(s) employed by the Contractor, who are responsible for receiving explosive deliveries and maintaining all explosive inventory and usage records, and providing safe and secure storage of explosive materials.

13. Maximum-Charge-Weight-per-Delay: For purposes of vibration control, any charges firing within any eight millisecond time period are considered to have a cumulative effect on vibration and Air-Overpressure effects. Therefore, the maximum charge per delay equals the sum of the weight of all charges firing within any eight millisecond period.

14. Peak Particle Velocity (PPV): The maximum of the ground motion velocities measured in the vertical, longitudinal, and transverse directions. PPV is not the vector sum of the three components of motion. Velocity units are expressed in inches per second (in/s).

15. Powder Factor: Explosive distribution expressed in pounds of explosive per bank cubic yard of rock shot.

16. Primary Initiation: The method whereby the Blaster-in-Charge initiates the blast(s) from a remote and safe location.

17. Seismograph: Automated electronic instrument installed to collect and transmit ground vibration data obtained from an electronic vibration sensor or Geophone at set time intervals to data acquisition unit for automated processing and data presentation. Also used to measure Air-Overpressure (air blast) via use of microphone placed approximately two feet above ground.

18. Smoothwall Blasting (Trim Blasting): A form of Controlled Blasting used in trench and underground excavations. With this method, appropriately designed, small diameter, lightly loaded uniform continuous charges are placed in relatively close-spaced holes and timed to fire such that a well-relieved open face provides relief when removing the final burden of rock in front of trim holes drilled at the excavation limits.

19. Stemming: Crushed stone, sand, or other inert material placed in the unloaded collar area of blastholes for the purpose of confining explosive charges and limiting rock movement and Air-Overpressure.

20. Subdrilling: The portion of a blasthole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blastholes.

21. Vibration Monitoring Point (VMP): Monitoring point that measures velocities of the ground vibrations resulting from construction activities and noise levels from Air-Overpressure (air blast). Measurement shall be by use of Seismographs.

22. Vibration Specialist: The approved person designated to determine compliance with the specified vibration limits and interpret the Seismograph records.

B. Reference Standards:

1. Bureau of Alcohol Tobacco and Firearms (BATF)

a. Title XI, Regulation of Explosives (18 U.S.C. Chapter 40; 84 Statute 952). of the Organized Crime Control Act of 1970 (84 Statute 922) and 27 CFR 55.

2. Code of Federal Regulations (CFR):

a. 29 CFR 1926 - Safety and Health Regulations for Construction (OSHA)

b. 49 CFR 106, 107, 171-179, 383, and 390-399 (Department of Transportation (DOT)

3. New York State Department of Labor, Part 39 – Possession, Handling, Storage and Transportation of Explosives

4. Town of Greenburgh Code, Part I, Chapter 140, “Explosives, Blasting, and Rock Chipping” and Town of Mount Pleasant Code, Part I, Chapter 104 Article IV, “Explosives, Ammunition and Blasting Agents”.

1.05 DESCRIPTION

A. General construction requirements for rock excavation are specified in Section 31 23 25 – Rock Excavation.

B. This Section describes requirements for the use of explosives for all drill and blast Work involving the rock excavation by Controlled Blasting.

C. The Work covered in this Section includes, but is not limited to: blast design, blast limitations, materials, equipment, labor, supervision for the transportation and storage of explosives, drilling and loading of blast holes, protection of existing facilities, test blasts, blast-effects monitoring, condition surveys for existing

structures and facilities during blasting operations and damage repairs for damage resulting from blasting operations.

D. Vibration monitoring:

1. The Contractor shall discuss in detail his/her selected means, methods, sequence of work and execution of the Contract Work with the Geotechnical Instrumentation Engineer (GIE) and shall jointly prepare a complete list of all the construction activities, which includes blasting, that will induce construction vibrations at the sites. The GIE requirements are specified in Section 31 09 00 - Geotechnical Instrumentation and Monitoring.

2. The Contractor and GIE jointly shall evaluate complete list discussed above and prepare a selected list of construction activities that will induce vibrations in ground and could have damaging effect on the Contract Work. Based on the selected list, GIE shall prepare and submit a vibration monitoring plan for approval which includes placement of additional Structural Deformation Monitoring Points (SDMPs) and VMPs identified as 'To Be Determined (TBD)' on Tables 1 in Section 31 09 00 - Geotechnical Instrumentation and Monitoring. Vibration monitoring plans shall also include details of the Contractor's means, methods, sequence of work and execution of the Contract Work; details of complete and selected list as discussed above, and basis of preparation of selected list.

3. For vibration monitoring, Seismograph readings shall be collected and averaged, at minimum, from three locations per blast location or as approved by the Engineer. The Seismographs shall be located on ground or surface structure nearest to the area where active construction activities inducing vibrations are being performed. Seismograph locations shall be as per approved vibration monitoring plans or as directed by the Engineer.

DI. Noted Restrictions:

1. The Contractor shall provide written notice to adjoining lots, buildings and service facilities which may be affected by blasting operations at least five days prior to when blasting is scheduled to commence at a blast location.

2. The Contractor shall comply with the requirements of the Town of Mount Pleasant Engineer, regarding the quantity, storage, handling, and use of explosives needed for the Work.

3. Prior to any blasting commencing at any site, the Contractor shall arrange a meeting with representatives of the Town of Mount Pleasant Engineer, DEP and adjacent utility companies to review the blasting to be done at the site.

4. Restrictions on the transport and delivery of explosives, and the allowable hours of blasting are specified in the Blasting Permit issued by Town of Mount Pleasant and Code of the Town of Mount Pleasant, included in Section 01 41 00 – Regulatory Requirements.

5. Blast Vibration and Noise (air-over pressure) Requirements:

a. The following limits shall be used for the overpressure resulting from blasting on this Project:

1) The maximum allowable concussion or air blast resulting from blast operations shall not exceed 130 decibels peak, measured at a flat Frequency response (PMS two decibels) over the range of at least six to 200 hertz

b. The following limits shall be used for the vibrations resulting from blasting on this project:

1) The maximum allowable Peak Particle Velocity shall not exceed 0.12 in/s for the following critical infrastructure within the blasting impact area:

a) Upper Effluent Chamber (UEC)

b) Lower Effluent Chamber (LEC)

c) Dike Grade Tunnel (DGT)

2) The maximum allowable Peak Particle Velocity shall not exceed 0.5 in/s for the following within the blasting impact area:

a) DEP structures including all buildings, except for the UEC, LEC, and DGT

3) The maximum allowable Peak Particle Velocity shall not exceed 1.25 in/s for the following within the blasting impact area:

a) Regular building structures

b) Pavement

c) Existing cut slope

d) Existing Utilities

(1) Telecom Line

(2) Sanitary Water Pipe

(3) Fire/Water Pipe

(4) Chemical Lines (Chlorine and Fluoride Lines)

(5) Electric Tower Foundation

4) Blasting shall not occur within the vicinity of concrete that has been placed within the preceeding 10 hours.

c. Air-Overpressure measured at the nearest residential or business structures within a distance of 500 feet from the blast location

susceptible to damage or claims of annoyance shall not exceed 130 decibels (linear scale). Microphones shall be located at least two feet above the ground surface and shall be pointed toward the blast site.

d. Blast-induced vibration measured in any one of three mutually perpendicular directions shall not exceed the maximum PPV as stated for infrastructure in "Blast Vibration and Noise (air-over pressure) Requirements" para above or for other designated location as approved by the Engineer. If PPV exceed the maximum PPV, the Contractor shall amend blast designs to assess methods to reduce vibration levels not to exceed the maximum PPV and obtain Engineer's approval before proceeding with blasting operations.

e. Vibration Limitations for Green Reinforced and Unreinforced Concrete Constructed in this Contract: PPV shall not exceed 2.0 in/s as measured by a portable Seismograph placed at lining closest to vibration source. Reduce maximum permissible PPV if movement or cracking is detected. Threshold values for PPV reporting and taking action shall conform to requirements specified in Sections 3.02 and 3.03.

6. Photographs of the blasting operations are prohibited. Cameras shall not be allowed within the site area when any blasting operations are in progress.

F. Design Criteria:

1. The following shall apply to blasting in all areas of Work:

a. The firing systems for the general blast holes shall be controlled by the use of non-electric delay detonators.

b. Blast designs shall include measures that prevent all forms of misfires and ensure complete detonation of all explosives.

c. All drill-and-blast operations shall be done by means of Controlled Blasting. Acceptable Controlled Blasting methods will be those utilizing Smoothwall Blasting or Line Drilling techniques. Use of "pre-splitting" or any form of cushion blasting in surface excavations is specifically prohibited.

d. Underground Blast Rounds:

1) The diameter of all holes charged with explosives shall not exceed 2.5 inches.

2) Only fixed-cartridge or packaged explosives shall be used.

G. Scheduling and Sequencing:

1. Blast only as per approved General Blasting Plan prepared by the Blasting Consultant.

2. Warning signs and public notification are required to avoid all risks to the public. These notifications shall be provided by Contractor at locations approved by the Engineer.

3. The Contractor shall be responsible to coordinate each blast round as appropriate and set up communications between Contractor, the Town of Mount Pleasant and Engineer as per approved Blasting Safety Plan. All delays and associated cost caused by Contractor's failure to provide timely communications among parties shall be the responsibility of the Contractor.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Blasting Consultant shall have a minimum of ten years of experience in preparing Controlled Blasting designs for surface rock excavation operations occurring near critical structures and sensitive neighborhoods and shall be approved by the Engineer. Blasting Consultant shall document the completion of at least three projects of similar scope and complexity. The Blasting Consultant shall also have thorough knowledge of all blasting methods used to control over break and damage to rock, excavation supports and concrete works.

   a. The Blasting Consultant shall be retained for the duration of controlled blasting Work at the Project site. The Blasting Consultant shall also be on site during all test blasting and at least once per month during production blasting.

2. Blaster-in-Charge shall have a minimum of ten years of experience in Controlled Blasting work for similar excavations in rock. The Blaster-in-Charge shall document the completion of at least three projects of similar scope and complexity.

3. The Contractor shall engage the services of a qualified Vibrations Specialist to determine compliance with specified vibration limits, and to interpret the Seismograph records to ensure that the Seismograph data is effectively utilized in the control of the blasting operations with respect to the existing structures. The Vibrations Specialist used shall be subject to the Engineer's approval. The Vibrations Specialist shall be separate from and independent of the Blasting Consultant noted above.

   a. The Vibration Specialist shall be retained for the duration of the Controlled Blasting work on this Project.

   b. The Vibrations Specialist shall have experience in vibration monitoring work, involving Controlled Blasting for surface rock excavation, and shall have a minimum of five years experience in performing such work on at least three similar projects.

4. Licensed Professionals:

a. All condition survey Work shall be performed by an independent consulting firm, employing New York State Licensed Professional Engineers, retained by the Contractor, to observe and record the condition of existing structures and facilities in the vicinity of the Work. The consulting firm and Professional Engineers each shall have a minimum of ten years experience in performing such work on at least two similar projects.

B. Certifications and Training:

1. Blaster-in-Charge and Blasters shall have valid Certificates of Competence in accordance with New York State Department of Labor, Part 39 – Possession, Handling, Storage and Transportation of explosives.

2. The Contractor's supplier of explosives and detonators shall conduct Blasting Safety and Applications Training to all personnel handling such materials. The Contractor shall provide written verification to the Town of Mount Pleasant and the Engineer on the personnel who were trained. Such verification shall include the date and time of the training session and an agenda of the training session.

3. The Contractor shall also obtain all other training as required by the Town of Mount Pleasant, BATF, NYS Department of Labor and other agencies as appropriate. The cost of such training shall be borne by the Contractor.

C. Acceptance Criteria:

1. Before each blast, the Blaster-in-Charge shall certify in writing to the Town of Mount Pleasant and the Engineer that all installations and operations are done in accordance with General Blasting Plans as described herein.

D. Permits:

1. Obtain and pay for all permits and licenses from applicable, federal, state, and local agencies in connection with all drill and blasting operations. These permits include but are not limited to:

a. Town of Mount Pleasant Town Building Permit to cover any blasting that may be required

b. 1) Granted by the Town Building Inspector

c. Individual blaster licenses, and

d. BATF permits for Transport.

2. Copies of all such permits and licenses shall be supplied to the Engineer.

1.07 SUBMITTALS

A. Qualifications: A minimum of 180 days prior to the start of Blasting Work, submit the following evidence of experience and qualifications to the Engineer:

1. Details of education, training, and experience including Certificates of Competence in accordance with New York State Department of Labor, Part 39 – Possession, Handling, Storage and Transportation of explosives, for all proposed persons that will be immediately in charge of drilling and blasting operations.
2. The names of the Blaster-in-Charge(s) whom the Contractor plans to retain to perform blasting work. Separate qualifications shall be submitted for each supervising Blaster-in-Charge. Contractor's submittal shall include names, addresses, and telephone numbers of at least three persons who can verify such prior successful experience. Copies of valid New York State blasting licenses shall also be submitted for all Blaster-in-Charge(s) .
3. The name and qualifications of the Blasting Consultant whom the Contractor plans to retain to facilitate the development and/or review of all blasting designs and blast-effect control measures.
4. The name and qualifications of the Vibrations Specialist whom the Contractor plans to retain to facilitate the measurement and conformance of vibrations.
5. Qualifications of the independent consulting firm, employing New York State Professional Engineers, retained by the Contractor performing the condition surveys for existing structures and facilities.
6. Qualifications of the Blaster-in-Charge, Blasters and supervising shift forepersons: Blaster-in-Charge shall have a minimum of five years of experience) in similar excavations, rock and Controlled Blasting techniques.

B. Certificates:

1. Copies of Certificates of Fitness for all Blasting Consultants, Blaster-in-Charge(s), blasters, drillers, helpers, Magazine Keeper, and all persons involved in blasting work.
2. Copies of certificates of training for all personnel involved in the blasting as specified in this Section.
3. Copies of required explosive use and storage licenses, and individual blaster licenses.
4. Copies of any required regulatory variances.
5. The certificate of Seismograph calibration performed by the manufacturer, two weeks prior to the start of vibration monitoring Work at a Site. Subsequently, Seismograph calibration certificate performed by the manufacturer shall be submitted at least twice a year for the duration of Controlled blasting Work of the Contract

C. Product Data:

1. The Test Blast Plan and General Blasting Plan shall contain Product Data: Manufacturer' s product information sheets and Material Safety Data Sheets (MSDS) for all explosives, blasting agents, primers and initiator products, blasting devices, lightning detectors, blasting mats, and all other blasting equipment and specific equipment used for communication for employees working underground.

D. Working Drawings:

1. Working drawings for test blasts and for each area of work, within the time frame described in this Section.

E. Quality Control:

1. Vibration Monitoring Plan: The Plan shall describe details of vibration monitoring locations, data collection and processing procedure, reporting, mitigation and control, including:

a. Detailed method statement for monitoring, processing data, and reporting.

b. Instrumentation locations.

c. Corrective actions for noncompliance in levels monitored.

d. Sample data forms and daily report format.

e. Details of complete and selected list of construction activities inducing vibrations in ground and those activities that could have damaging effect on the Contract Work as specified in this Section.

2. Condition Survey Reports:

a. Initial condition surveys reports for existing structures and facilities, 90 days prior to the start of construction and blasting work.

b. Final condition surveys reports for existing structures and facilities after completion of blasting Work at a site. Submit within thirty days after condition surveys are completed.

c. Include all field notes taken, sketches and diagrams, photographs, descriptions and reports, all signed and witnessed by those taking part in the condition survey, and further signed and sealed by the Professional Engineer responsible for the condition survey.

3. Prepare a Blasting Safety Plan that includes, at a minimum, the following:

a. A complete description of the clearing and guarding procedures that will be employed to ensure personnel, staff, visitors, traffic, and all other persons are restricted to safe locations during blasting. This information shall include details regarding visible warning signs or flags, audible warning signals, method of determining blast areas (all areas affected by any potentially harmful blast effects), access blocking methods, traffic control plan, guard placement and guard

release procedures, Primary Initiation method, control of potential radio Frequency interference, and the system by which the Blaster-in-Charge(s) will communicate with site security guards.

b. Detailed description of how explosives will be safely stored, transported, and used at the project work sites. The Blasting Safety Plan shall explain how storage magazines and explosive transport boxes and vehicles will satisfy all applicable local, state and federal regulations and safety plan. This plan shall also indicate how explosives will be inventoried, secured, and guarded to prevent theft or unauthorized use of explosives.

c. Detailed contingency plans for handling of misfires caused by cutoffs or other causes.

d. Fire prevention plan details, procedures, and limitations for work involving any open flames or sparks, description and location of all firefighting equipment, and firefighting and evacuation plans.

e. Seismic monitoring procedure: Description of the methods of monitoring for blast induced ground vibration and Air-Overpressure.

f. Air quality monitoring procedures: Description of the methods of monitoring for noxious fumes when blasting.

g. Certificates from all regulating agencies and insurance companies.

h. Initial and ongoing blasting and fire-safety training programs.

i. Description of the personal protective equipment that will be used by Contractor's personnel conducting blasting operations outlined in Contractor’s HASP (as required).

j. An outline of the initial blasting safety and applications training program to be administered by the Contractor's explosive vendor that will be attended by all persons directly involved with blasting operations including Blasting Consultant, Blaster-in-Charge(s), blasters, drillers, and helpers.

4. Obtain copies of all applicable codes, regulations, and ordinances, and keep readily accessible copies in the Project field office at all times. Contractor's Safety Supervisor or Safety Representative shall ensure that ongoing blasting work complies with all applicable regulations.

5. Test Blast Plan, General Blasting Plan and Blasting Schedule.

   a. General Blasting Plans, Test Blast Plan, Test Blast Interpretive Reports, and revisions to any of these plans shall be prepared by the Blasting Consultant and covered with a signed letter by the Blasting Consultant.

b. Test Blast Plan:

1) A minimum of 90 days prior to the start of blasting work at Kensico Site or as approved by the Engineer, the Contractor shall submit Test Blast Plans for the work areas described in this Section.

2) The Test Blast Plans shall contain the details of the planned excavation sequencing, drilling and blasting patterns, and methods of Controlled Blasting for test blast areas.

3) The Test Blast Plans shall be submitted to the Town of Mount Pleasant and the Engineer for review and approval before commencing any blasting, or at any time the Contractor proposes to change the drilling and blasting method.

4) The Test Blast Plans shall contain the following minimum information:

a) Elevation limits of proposed blasting, and sequencing of blasting for each area of the excavation.

b) Plan and section views of proposed drill pattern indicating hole size, hole depths and angles, hole pattern and spacing and expected rock types.

c) Drill steel diameter and bit types.

d) Stemming length and type of material used for Stemming.

e) Loading details including trade names, types, sizes of explosives.

f) Average round length or bench height; placement and pattern of relief holes.

g) Proposed initiation and delay sequence of blast holes.

h) Weight of explosives per hole and per delay and Powder Factors.

i) Calculated vibration levels and Peak Particle Velocities at locations as shown on the Contract Drawings or as specified by the Engineer. The Contractor shall consult the Engineer before preparing the Test Blast Plan and General Blasting Plan to identify the locations where vibration and

PPV will be monitored that are not shown on the Contract Drawings.

j) Calculated blast decibel level at locations specified by the Engineer.

k) Planned initiation sequence.

l) Proposed format of Blast Reports, for approval.

c. Test blast interpretive report, within 7 day of test blast.

d. Thirty days prior to commencing production blasting operations for each work area described in this Section, based on review of the test blast results and monitoring data, and evaluating its effectiveness, the Contractor shall submit a separate General Blasting Plan for review and approval. The General Blasting Plan shall also contain the details of the planned excavation sequencing, drilling and blasting patterns, and methods of Controlled Blasting for each area cited in this Section. The General Blasting Plan shall at minimum contain all the information listed above for the Test Blast Plan.

e. Submit a revised General Blasting Plan for any proposed changes to the drilling or blasting methods or procedures not later than one week prior to the proposed commencement of the change in the work.

6. Review of the General Blasting Plan by the Engineer and Blasting Consultant shall not relieve the Contractor of its responsibility for the accuracy and adequacy of the plan when implemented in the field.

F. Notification to Adjoining Property Owners

1. Provide copies of the written notifications provided to adjoining property owners.

G. Recordkeeping:

1. Blast Reports: Blast Reports of excavation work shall be maintained and signed by the Blaster-in-Charge. The Town of Mount Pleasant shall be provided with one copy of the Blast Reports for each blast detonated during each day's work on the following workday. The format of Blast Reports shall be in accordance with the approved Test Blasting Plan and General Blasting Plan. The Blasting Report shall include, but is not limited to the following information:

a. The name and license number of the Blaster.

b. The location of the blast.

c. The date and precise time of each blast.

d. The number of blasts

e. Graphical and written descriptions of specific location, orientation, number, diameter, hole depth, burden depth, stemming length of each blast hole, and distance between blast holes

f. The type and manufacturer of explosives used.

g. The sequencing, type, and manufacturer of the delays used.

h. The weather conditions, including temperature, wind direction and speed.

i. Total weight of explosive in the blast, maximum weight per hole and charge weight per delay period, and calculated Powder Factor.

j. Locations for blast monitors (both Air-Overpressure and vibration).

k. Printouts of vibration and Air-Overpressure readings from each Vibration Monitoring Point (VMP) Seismograph.

l. The seismograph serial number, range and gain setting, and date of last calibration.

m. The microphone serial number, air channel low frequency limit, and date of last calibration.

n. The name of competent personnel (GIE) carried out Air-Overpressure and vibration monitoring.

o. A description of any unusual occurrences, including but not limited to unanticipated rock fall, misfires, and equipment malfunctions

p. On a diagram of the accepted blast pattern, indicate each hole not drilled, drilled but not loaded, changes in spacing or in pattern delays, or in loading holes.

q. Evaluation of blast indicating fragmentation, condition of faces and recommended adjustment for the next blast.

r. Submit copies of all Blast Reports to the Engineer of each blast.

2. An Emergency Response Plan indicating types of explosive materials, storage locations and quantities shall be submitted and approved before explosives are allowed on the site.

3. Submit copies of a report for each site visit performed by the Blasting Consultant during performance of blasting Work documenting observations and specific observations and recommendations for changes to the General Blasting Plan. A site visit report shall be prepared by the Blasting Consultant and shall be submitted within three days after the site visit was made and prior to the next week's site visit.

4. Submit a written confirmation letter from the Contractor's explosive vendor stating that transportation procedures satisfy applicable law and regulations before starting work.

5. Submit a certificate of Seismograph calibration performed by the manufacturer thirty days prior to start of the blasting Work at a Site. Subsequently, submit Seismograph calibration performed by the manufacturer certificate at least twice a year. In addition, submit field calibrations of Seismograph performed by the Contractor's field representative on using Seismograph on weekly basis.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Contractor is responsible for knowledge of and compliance with applicable Federal, State, and local regulations, applicable to the purchase, transportation, storage, handling, and use of explosives, blasting agents, primers, initiators, and ancillary equipment and materials in accordance with 49 CFR 106, 107, 171-179, 383, 390-399, and 12 NYCRR 39.

B. Transportation: Contractor's explosive vendor has responsibility of satisfying applicable law and regulations regarding transportation procedures.

C. Whenever operations are in progress which may require blasting, such explosives shall be stored, handled, and used as per applicable Town of Mount Pleasant Town Code Chapter 104-20 to 104-23; the Labor Law of the State of New York and the Industrial Code Rules promulgated thereunder by the Board of Standards and Appeals of the New York State Department of Labor relating to the types of work to be performed under this Contract; and the Federal Occupational Safety and Health Act of 1970, the Construction Safety Act of 1969, and 29 CFR 1926 Subpart U as amended.

D. For any temporary or short-term storage, all explosive materials, detonators (including electric, electronic, and nonelectric), detonating cord, shock tube, safety fuse, igniters, and squibs must be stored in magazines constructed and located in accordance with federal, state and local regulations. Magazines should be kept locked at all times except for inspection, inventory, or the movement of explosive materials in or out of the magazine.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Seismograph manufacturer:

1. MiniMate Pro as manufactured by Instantel Inc., Kanata (Ottawa), Ontario, Canada;

2. Micromate-ISEE / Geo/Microphone System as manufactured by Blasters Tool & Supply Company/ Thomas Instruments Inc., Lawrenceburg, KY,

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Explosive Materials:

1. Only approved blasting systems shall be used. Cap and fuse method or standard electric pyrotechnic initiators shall not be used.

2. Only explosives approved by the Town of Mount Pleasant and the Engineer and designed and manufactured for Smoothwall (trim) Blasting shall be used for the primary column charges in perimeter holes.

3. Explosives, blasting agents, primers, initiators, and ancillary blasting materials shall be kept in original packaging with clearly marked date codes. All explosives and initiating devices used shall be less than one year old or within manufacturer's shelf life limits, whichever is more stringent.

4. If the Contractor, Blaster-in-Charge, Blasting Consultant, Engineer, or the City determines that a blasting product appears to be in a damaged or deteriorated condition, the suspect product shall not be used. Products determined to be damaged or in a deteriorated condition shall be immediately returned to the supplier for safe disposal.

B. Blast Monitoring Equipment:

1. Provide Seismographs with sensitive, low-frequency, three-component seismic recording instrumentation with waveform paper trace, variable vibration and noise trigger level settings, Peak Particle Velocity memory operation (in inches/second) and Air-Overpressure and sound level readout capability. Seismographs features include, but is not limited to as specified below:

a. Portable Seismographs (VMPs, with Geophones and microphones):

1) Provide portable Seismographs at the VMPs fitted with Geophones and microphones to monitor the velocities of the ground vibrations resulting from construction activities at locations shown and the additional locations to be proposed by the Contractor and agreed by the Engineer. The VMPs shall also have microphones to measure noise levels from Air-Overpressure (air blast). The Seismograph shall have the following minimum features:

a) Seismic range: 0.01 to 10 inches per second with an accuracy of ±5 percent of the measured PPV or better at frequencies between 10 Hertz and 200 Hertz, and with a resolution of 0.01 inches per second or less.

b) Acoustic range: 110 to 140 dB (referenced to 20 micro-Pascals) with an accuracy and resolution of ±1 dB.

c) Frequency response (±3 dB points): 2 to 200 Hertz.

d) Three channels for vibration monitoring plus a fourth channel for Air-Overpressure.

e) Two power sources: internal rechargeable battery and charger and 115 volts AC. Battery must be capable of supplying power to monitor vibrations continuously for up to 24 hours.

f) Capable of internal dynamic calibration.

g) Direct writing to printer and capability to transfer data from memory to a computer. Instruments must be capable of producing strip chart recordings of readings on site within one hour of obtaining the readings. Provide computer software to perform analysis, produce reports of continuous monitoring, and to perform zero-crossing frequency analyses of waveform data in electronic format.

h) Self-triggering wave form capture mode that provides the following information: plot of wave forms, Peak Particle Velocities, peak Air-Overpressure, frequencies of vibrations.

i) Continuous monitoring mode must be capable of recording single-component Peak Particle Velocities, and frequency of peaks with an interval of one minute or less.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. To facilitate compliance monitoring work, the Contractor shall notify the Engineer and the Town of Mount Pleasant of the planned times and locations of all blasts before they are scheduled to occur. If blasts are cancelled or the time scheduled for a blast is delayed more than one hour, the Town of Mount Pleasant and Engineer shall be notified of the cancellation or rescheduled time by telephone immediately. The Contractor shall not blast until the Contractor has received a notice to proceed from the Town of Mount Pleasant and Engineer. All delays caused by Contractor's failure to provide adequate blasting notification to the Town of Mount Pleasant will

be at the Contractor's expense. Notify the Town of Mount Pleasant immediately upon completion of the blasting.

B. The Contractor shall establish fail-safe procedures and protection devices that ensure that all persons are at safe locations before any blasting. Approved procedures shall be followed, including, but not limited to, the following:

1. Signboards displaying blast clearing and guarding procedures shall be displayed in lunch rooms, changing rooms and other locations where workers and visitors to blasting areas can clearly see them.

2. The Blaster-in-Charge shall direct all clearing and guarding operations and blasting shall be performed only after ensuring that all people and equipment have been removed to a safe location.

3. A "tag out" procedure shall be utilized to ensure that all persons are out of the blasting area before a blast.

4. Provide traffic control measures prior to and during blasting.

C. Vibration monitoring equipment shall be installed and tested to establish formal initial background readings agreed upon by the Engineer at least 30 days prior to any blasting or vibration inducing activities.

3.02 IMPLEMENTATION

A. General:

1. All blasting shall be in compliance with the following:

a. Bureau of Alcohol Tobacco and Firearms (BATF)

1) Title XI, Regulation of Explosives (18 U.S.C. Chapter 40; 84 Statute 952). of the Organized Crime Control Act of 1970 (84 Statute 922) and 27 CFR 55

b. Code of Federal Regulations (CFR):

1) 29 CFR 1926 - Safety and Health Regulations for Construction (OSHA)

2) 49 CFR 106, 107, 171-179, 383, and 390-399 (Department of Transportation (DOT)

c. New York State Department of Labor, Part 39 – Possession, Handling, Storage and Transportation of Explosives

d. OSHA 1926 Subpart U, Standard Number 1926.000, Blasting and Use of Explosives

e. OSHA 1910 Subpart H, Standard Number 1910.109, Explosives and Blasting Agents

f. The Town of Mount Pleasant code for the surface blasting work performed within the town limits, including but not limited to blasting permit acquired from the Building Department issued by the Building Inspector, a bond from the Contractor to be reviewed by the Town Attorney, all documentation to be accepted and approved by the Town Board, and details on blasting to be discussed and approved by the Blasting Inspector.

2. Blasting work at a site shall not begin until the condition surveys reports are prepared by the Contractor and accepted by the Engineer.

3. The Contractor shall implement a Blasting Safety Plan, as approved by the Engineer, and in accordance with applicable standards.

4. The Contractor shall use care so as not to endanger life or property or disturb materials outside the limits of the excavation.

5. The Contractor shall implement approved traffic control plan prior to and during any blasting work in progress.

6. Blasting will not be permitted when, in the opinion of the Engineer, it may be detrimental to existing work, or result in unacceptable environmental impacts. The Engineer's decision shall be final.

7. The Contractor shall provide all necessary types of tools and devices required for handling and using explosives, blasting caps, and accessories. The Contractor shall conform to and obey all federal, state and local laws that may be imposed by any public authority having legal jurisdiction.

8. Ample warning shall be given to all persons within the vicinity prior to blasting. Warning signs shall be erected a minimum of 24 hours prior to the blast time, and workers shall be stationed to warn people before firing any blasts. The warning signs will state the time and date of each blast.

9. Before the firing of any blast, the rock to be blasted shall be covered with approved blasting mats, soil or other equally serviceable material, to prevent Fly Rock.

10. Blasting monitoring shall be conducted by the Blasting Consultant using approved monitoring devices. The Blasting Consultant shall be responsible for the location and placement of these monitoring devices. Monitoring locations shall be as shown on the Contract Drawings. In addition, a minimum of four locations that are not shown on the Contract Drawings shall be monitored as determined by the Blasting Consultant in conjunction with the Engineer. The Air-Overpressure measuring instrument shall be located so that any wind at the time of the blast is blowing from the location of blasting toward the instrument. During the peak sound pressure tests, all required blast information shall be recorded, including exact blast location, instrument location with distance and direction from the location of blasting, and weather conditions (type of day, wind direction, and wind

velocity). The Contractor shall be responsible for the protection of these monitoring devices from its equipment and operations. The Blasting Consultant shall analyze monitoring devices and recordings and notify the Engineer and Contractor immediately if Air-Overpressure and/or vibrations exceed permitted values.

11. To ensure the accuracy of firing times of blasting caps, each cap period shall come from one lot number. Mixing lot numbers for any one cap period is prohibited.

12. After a blast has been fired and fumes have been cleared from the shaft, the Blaster-in-Charge shall inspect the blast site to determine that all charges have exploded before employees are allowed to return to the operation. Misfires shall be corrected in accordance with the requirements of the applicable portions of the federal, state, or local safety codes for blasting. The Contractor shall be responsible for any and all damage to property or injury to persons resulting from blasting or accidental or premature explosions that may occur in connection with its use of explosives.

13. Remove all loose and shattered rock that may endanger the structure or the work. Make the excavation safe before proceeding with the work. Removal of loose or shattered rock or other loose material may enlarge the excavation beyond the required limits but shall not relieve the Contractor of the responsibility for removal of such material, and subsequent additional backfill or concrete placement. The Contractor shall not be entitled to additional payment for over-excavation or overbreak, unless the rock conditions are outside of the baselines set for blasting in the Geotechnical Baseline Report.

B. Ground Subsidence and Condition Surveys for Blasting Work:

1. Ground subsidence surveys shall be performed prior to the start of blasting activity at and around the Kensico Site for rock excavation and later shall be repeated on completion of blasting work included in this Section as follows

a. The ground subsidence survey shall be made by a New York State licensed land surveyor, retained by the Contractor, to establish control points to monitor ground subsidence at the facilities and properties. The condition survey shall include all areas of existing ground surface located entirely or partially within 500 feet horizontal distance from the location of surface rock blasting at the Kensico Site, including structures, roadways, and facilities located thereon and therein, which are likely to be affected by the construction and blasting operations of the Contractor. The ground subsidence survey shall include area with critical DEP structures, including Dike Grade Tunnel (DGT), LEC, and UEC. Within these areas, control points for recording elevations shall be selected by the Contractor, and approved by the Engineer, at projecting ledges of

foundations or other features of existing buildings and walls, as well as along roads, curbs, walks, paved areas, and at manholes, monuments, and other dominant features.

b. The Contractor shall record the elevations of control points to monitor ground subsidence and as may be necessary shall also prepare drawings and take photographs of these points, and submit to the Engineer for approval. Such elevations shall be surveyed by the Surveyor before, during and after excavation of construction work, as appropriate, and they shall be taken as often as may be necessary in the opinion of the Engineer, but in no case at an interval to exceed one week, to verify the adequacy of the excavations and the construction procedures employed by the Contractor for prevention of ground subsidence and to obtain sufficient evidence for use in defense against possible claims for damage by third parties. All elevations obtained by the Contractor shall be recorded on the drawings referred to above and copies thereof, together with signed copies of survey notes witnessed by those taking part in the survey, promptly delivered to the Engineer.

c. In the event that the subsidence surveys indicate an inadequacy of excavation or construction procedures employed by the Contractor for prevention of subsidence, correction of such procedures shall be promptly initiated by the Contractor to the satisfaction of the Engineer, and work may be temporarily suspended by order of the Engineer until the Contractor uses approved revised procedures. Action by the Engineer in this respect or his failure to act thereon shall not form the basis of claim for additional payment or extension of time under the Contract and shall not relieve the Contractor of full responsibility for performance of the Work under the terms of the Contract.

2. Condition surveys for existing structures and facilities shall be performed prior to the start of blasting activity at and around Kensico Site for rock excavation and later shall be repeated on completion of blasting work included in this Section as follows:

a. The condition survey shall be made by an independent consulting firm, employing New York State Professional Engineers, retained by the Contractor, to observe and record the condition of existing structures and facilities in the vicinity of the work. The condition survey shall include all structures and facilities located entirely or partially within 500 feet horizontal distance from the location of surface rock blasting at the Kensico Site. The condition survey shall include critical DEP structures, including Dike Grade Tunnel (DGT), LEC, and UEC at Kensico Site. Detailed descriptions and photographs shall be taken of all existing cracks, interior basement

or foundation cracks, exterior cracks or damage to exterior walls, pavements and sidewalks, and such other data as is applicable to locate and define the amount and extent of existing damage.

b. As construction progresses, the consulting firm shall repeat condition surveys as ordered or directed by the Engineer, to verify the adequacy of the Contractor's blasting procedures for prevention of damage and to obtain sufficient evidence for use in defense against possible claims for damage by third parties. Data obtained by the consulting firm from each repeated condition survey shall be promptly delivered to the Engineer in electronic PDF format.

c. In the event that the condition survey indicates an inadequacy of the blasting procedures employed by the Contractor for the prevention of damage, correction of such blasting procedures shall be promptly initiated by the Contractor to the satisfaction of the Engineer, and blasting work may be temporarily suspended by order of the Engineer until revised and approved blasting procedures are employed.

3. Repeat the condition survey in the following circumstances:

a. When there are claims of damage;

b. When instrumentation indicates that there is evidence of exceeding vibration limits specified in this Section.

4. The Contractor shall perform final condition surveys on completion of all blasting work. The condition surveys shall be performed by the Contractor thirty days after completion of blasting work or as directed by the Engineer.

5. Nothing contained herein shall relieve the Contractor of responsibility for claims arising from its construction operations. Failure to inspect any structure and facility as required by the Contract Documents, or inadequacy of the inspections shall not relieve the Contractor of its responsibility.

6. All surveys shall be performed using the same horizontal and vertical datum used for the Contract Drawings. see Section 01 43 05 – Contractor's Work Quality.

C. Test Blasts:

1. Before any production blasting, the Contractor shall perform test blasts in accordance with the Test Blast Plan to determine means, methods, and procedures to limit potential blast impacts on structures and facilities.

2. Contractor's Blasting Consultants and at least one qualified technical representative from the explosive supplier shall be on Site to facilitate test-blasting activities at the Contractor's expense.

3. A Test Blast Plan and location for each area shall be submitted and reviewed by the Engineer before drilling for test blasts.

4. The Test Blast Plan will be reviewed by the Engineer and Blasting Consultant. The Blasting Consultant shall review the test blast results and monitoring data and evaluate the effectiveness of initially specified blasting controls before allowing full-scale blasting.

D. Production Blasting:

1. Conduct production blasting operations in a manner to keep Air-Overpressure and ground motion at critical surface and underground structures, adjacent facilities, private and public structures, and structures constructed in this Contract within the specified limitations. If blast-induced Air-Overpressure or vibration levels exceed the performance requirements specified herein, suspend blasting in the affected excavation(s) until a re-designed blasting plan is submitted to and reviewed by the Engineer.

2. The Contractor shall conform to the blast vibration and Air-Overpressure requirements specified in Section 1.05F. The Contractor shall suspend blasting in the affected excavation(s) if the threshold value specified herein is reached, until a re-designed blasting plan is submitted, reviewed and approved by the Engineer.

3. Before conducting blasting operations, the Contractor shall inspect and check conditions of instrumentation measuring Air-Overpressure and vibration. If an instrument is defective, it should be replaced before the blast. All instruments shall be checked prior to each blast.

4. Production blasting shall be conducted in accordance with the designs determined from the test blasting.

5. Limitations:

a. Controlled Blasting techniques shall be used to minimize overbreak and minimize rock damage in all excavations. Blast patterns shall be designed so that the explosive energy is not directed into the back and finished surface of the excavation but instead, towards the developed free face.

b. Whenever, in the opinion of the State, Town of Mount Pleasant and the Engineer, proposed blasting may cause harm to persons, cause damage to· structures, or create unacceptable rock instability, cease blasting immediately and review the blast design. Contractor shall resume excavation of the rock with a re-designed blast plan submitted to and reviewed by the Engineer.

6. Misfires and Dangerous Conditions: After a blast has been fired, the Blaster-in-Charge shall make a careful inspection of the blast area. The Engineer shall be present for this inspection. Inspections shall determine whether there are any indications that misfires might have occurred or whether the blast created any other imminent dangers such as unstable ground conditions. If misfires or other dangerous conditions are found, the

Blaster-in-Charge shall immediately notify the Town of Mount Pleasant , the State and the Engineer, secure the area and properly correct all hazards before any other Work is allowed in the affected area. The all clear signal, allowing other work to resume in the area, shall not be given until affected blast sites are clear of all hazards.

7. Review and Modification Methodology: If vibrations and noise exceed permitted values specified herein, the Contractor shall modify the General Blasting Plan and submit it for review by Engineer.

E. Suspension of Blasting:

1. Blasting operations may be temporarily suspended by the Town of Mount Pleasant or Engineer for any of the following reasons:

   a. Contractor's safety precautions are inadequate;

   b. Non-compliance with the approved General Blasting Plan;

   c. Air-Overpressure and/or ground vibration levels exceed specified limits;

   d. Excavation by drill and blast results in excessive overbreak and/or over-excavation;

   e. Unacceptable air quality in surface Rock excavations;

   f. Blasting endangers the stability of or causes damage to adjacent structures or facilities;

   g. Instrumentation for measuring Air-Overpressure and vibration are found broken or defective.

   h. The results of the blasting, in the sole opinion of the Town of Mount Pleasant or the Engineer, are not satisfactory.

2. Blasting operations shall not resume until the State, Town of Mount Pleasant and the Engineer have reviewed Contractor's revised blasting plan with modifications correcting the conditions causing the suspension.

3. The cost associated with temporary suspension of blasting operations shall be borne by the Contractor.

F. Monitoring

1. Vibration Monitoring (VMPs):

   a. Vibration control and Air-Overpressure (air blast) monitoring shall be implemented as specified herein Section 31 70 20 – Controlled Blasting and as directed by the Engineer. VMPs shall be operational and monitoring/recording throughout the entire duration of all blasting operations.

   b. The portable Seismographs shall be used concurrently to monitor vibrations at the pre-determined vibration control monitoring points

in the Contract Drawings and Section 31 09 10 – Geotechnical Instrumentation and Monitoring. Additional locations shall be proposed/submitted by the Contractor and agreed by the Engineer.

c. Seismograph's vibration sensors and microphones shall be firmly mounted on the concrete surface of slab, asphalt, concrete wall, or firmly set in undisturbed soil.

G. Damage Repair:

1. If blasting operations damage existing structures and facilities, off site properties, or any portion of the Work, or material surrounding or supporting the Work, the Contractor shall promptly repair or replace damaged items to the condition that existed before the damage, to the satisfaction of the Engineer at no cost to the City. The Engineer and City shall be notified immediately of any damage.

2. Nothing contained herein shall relieve the Contractor of its responsibility for claims arising from its construction operations.

3.03 FIELD TESTING / QUALITY CONTROL

A. The Blasting Consultant shall be responsible for the overall quality of the Controlled Blasting work.

B. Blasting Consultant's specific duties and responsibilities throughout blasting efforts include:

1. Review all pertinent geotechnical data and become familiar with condition and location of all neighboring property.

2. Development and implementation of Controlled Blasting designs.

3. Development and implementation of an effective vibration monitoring program.

4. Development and implementation of an effective means to reduce Air-Overpressures.

5. Development and implementation of an effective means to control dust produced by blasting.

6. Development and implementation of a Blasting Safety Plan that covers all of the concerns identified in this Section.

7. Visit site as specified and requested by the Engineer, during the period of blasting operations.

8. Participation in meetings requested by the Town of Mount Pleasant and/or Engineer to discuss interpretation of monitoring records, blast damage, changes in blasting techniques, and location of vibration and air blast monitoring sites.

9. Review of all blast vibration and air blast records and reports and recommendation of changes in blasting techniques in order to reduce excessive ground vibrations, Air-Overpressures, or to improve Fly Rock control, rock fragmentation and the quality of the final cut faces obtained.

10. Preparation of reports after each site visit documenting observations and specific observations and recommendations for changes to the blasting program.

11. Review of condition surveys reports.

12. Investigate and recommend alternative plans or modifications when vibration, air blast or any other Contract requirement is violated or when blasting complaints are received.

C. Data Reduction, Processing, Plotting, and Reporting:

1. Plots of Seismograph data shall be the following types: strip charts and full-wave form plots. Strip charts shall be used to monitor continuously and record Peak Particle Velocities produced for blasting. Full-wave form plots shall be used to record vibrations during blasting activities. Full-wave form plots shall consist of a graphical display of the three component particle velocities and peak sound during the entire course of the blasting event. During the blasting event, the Peak Particle Velocities, accelerations and displacements, as well as sound levels (in pressure and decibels), shall also be recorded. All full-wave form data should be printed and stored electronically for future analysis. At the end of each day, the Contractor shall prepare a table which summarizes the maximum particle velocities and sound levels for each blasting event during the day. Plots of Seismograph data for blasting shall be prepared per blast event and shall be similar to approach discussed in this paragraph

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 32 12 16 - ASPHALT PAVING
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide asphaltic concrete pavement roads and walks constructed on properly prepared subgrades and in conformance to the required lines, grades and cross sections shown on the Contract Drawings.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 02 41 10 - Demolition and Removals

B. Section 31 23 16 - Excavation

C. Section 31 23 23 - Fill

1.04 REFERENCES

A. Definitions

1. California Bearing Ratio (CBR): The ratio of (1) the force per unit area required to penetrate a soil mass with a 19 sq. cm (3 sq.in.) circular piston (approximately 51 mm (2 in.) diameter) at the rate of 1.3mm/min (.05 in/min) to (2) that required for corresponding penetration of a standard material.

2. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

3. Typical Roll Value: Property value calculated from average or mean obtained from test data.

B. Reference Standards

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m3))

3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

4. ASTM D3666 - Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

5. ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method

6. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

7. ASTM D4354 - Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

8. ASTM D4355 - Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus

9. ASTM D4491 - Test Methods for Water Permeability of Geotextiles by Permittivity

10. ASTM D4533 - Test Method for Trapezoid Tearing Strength of Geotextiles

11. ASTM D4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

12. ASTM D4632 - Test method for Grab Breaking Load and Elongation of Geotextiles
13. ASTM D4759 - Practice for Determining the Specification Conformance of Geosynthetics
14. ASTM D4751 - Test Method for Determining Apparent Opening Size of a Geotextile
15. ASTM D4833 - Test Method for Index Puncture Resistance of Geomembranes and Related Products
16. ASTM D4873 - Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples
17. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
18. AASHTO T 27 - Sieve Analysis of Fine and Coarse Aggregates
19. AASHTO T 88 - Standard Method of Test for Particle Size Analysis of Soils
20. AASHTO T 311 - Standard Method of Test for Grain-Size Analysis of Granular Soil Materials
21. AASHTO T 89 - Standard Method of Test for Determining the Liquid Limit of Soils
22. AASHTO T 90 - Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils
23. AASHTO T 176 - Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
24. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP)
25. International Standards Organization (ISO) 9001 - Quality Management Systems — Requirements
26. New York State Department of Transportation (NYSDOT) Standard Specifications
27. Federal Highway Administration- Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)
28. New York City Local Law 71 of 2011

1.05 DESCRIPTION

A. Not used

1.06 QUALITY ASSURANCE

A. The paving mix manufacturer shall be registered with and approved by NYSDOT.

B. Sub-base materials shall comply with the testing and certification requirements of Section 31 23 23 – Fill.

C. Recycled Portland Cement Concrete Aggregate shall comply with the procedures contained in the Geotechnical Control Procedure (GCP-17) "Procedure for the Control and Quality Assurance of Granular Materials: as per NYSDOT Standards and Specifications section 733-07.

D. Geotextile fabric manufacturer shall be approved by NYSDOT.

E. Manufacturers shall comply with ASTM D3666.

1.07 SUBMITTALS

A. The Contractor shall submit shop drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Geotextile

a. Manufacturer's literature including physical, mechanical and chemical properties of the geotextile.

b. Certification of geotextile's minimum MARVs and tests used to determine those properties.

c. Certificate of Compliance stating that the geotextile conforms to the Specifications and the manufacturer is aware of and agrees with its intended use.

d. Geotextile manufacturer's qualifications: ISO 9001 certified or equivalent.

e. Manufacturing quality control test results on geotextiles.

2. Asphalt Concrete

a. The bituminous mix design for both the binder course and the top course, which shall include the sources of all ingredient materials, Recycled Asphalt Pavement (RAP) content by weight, the penetration of the asphaltic cement and the percentages by weight and the number of pounds of each of the materials making up one batch.

1) The laboratory analysis of the bituminous mix and the laboratory compacted density.

3. Recycled Portland Cement Concrete Aggregate (RCA) Material

a. Name of location of all suppliers.

b. Certificate of compliance with standard specified for each source of material.

c. Prior to stockpiling or placing of materials at the job site, submit for approval samples representative of the material at the proposed

borrow source. In addition, submit documentation of the availability of the required material quantities at any proposed borrow source.

d. Certification by the material borrow source of the gradation as per ASTM D 422 for the gravel, RCA and any other materials being used. The minimum number of tests shall be determined by quantity of material placed, and reports of the test results shall be submitted promptly.

e. RCA shall also comply with the testing and certification requirements of Section 31 23 23 – Fill.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered to the site shall be stored in a manner to prevent contamination and segregation.

B. Geotextile

1. Geotextile delivery, storage, and handling shall comply with the requirements of NYSDOT Standard Specifications Section 207-3.01.

2. Wrap geotextile in black protective wrap.

3. The geotextile rolls shall be labeled as per ASTM D4873.

4. Deliver, store and handle rolls in manner to prevent damage.

5. After unloading, inspect rolls for defects and damage.

6. Protective wrapping should not be removed until ready for installation. Do not leave covered rolls exposed to elements for more than 30 days unless additional heavy-duty waterproof cover is provided. At no time shall the geotextile be exposed to ultraviolet light for a period exceeding 14 days.

7. Store rolls off ground, protected from precipitation, ultraviolet radiation, strong chemicals, sparks and flames, temperatures in excess of 160 °F and other environmental conditions that could cause damage to geotextile.

8. Prevent damage to wrappings and geotextile.

9. Rolls should be deployed as closely as possible to the designated location to avoid dragging. Excessive stress and movement should be kept to a minimum.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Geotextiles shall be as manufactured by:

1. Propex Fabrics, Chattanooga, TN;
2. TenCate Geosynthetics, Pendergrass, GA;
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Geotextile: Provide geotextile fabric conforming to the requirements specified in this Section:

1. Woven high-performance/high-strength slit film polypropylene geotextile; individual slit films woven together in manner to provide dimensional stability relative to each other.
2. Resistant to ultraviolet degradation and biological and chemical environments normally found in soils.
3. Minimum Average Roll Values:

Property	Test Method	Units	Results
Wide Width Tensile Strength	ASTM D4595	kN/m (lbs/in)	31x30.6 (175 x 175)
Grab Tensile Strength	ASTM D4632	N (lbs)	1335 x 1335
Grab Elongation	ASTM D4632	Percent	15 x 15
Puncture Strength	ASTM D4833	N (lbs)	555 (125)
Mullen Burst	ASTM D3786	KPa (psi)	4475 (650)
Trapezoidal Tear	ASTM D4533	N (lbs)	530 x 530
Apparent Opening Size	ASTM D4751	mm	0.212
Permittivity	ASTM D4491	sec-1	0.06
Water Flow Rate	ASTM D4491	$1/min/m^2$ (gpm/ft^2)	200 (5)
UV Resistance (percent retained at 500 hours)	ASTM D4355	Percent	90

B. Provide asphaltic concrete pavement for roadways conforming to the requirements specified in this Section and to the following standards:

1. Sub-base Course of Recycled Concrete Aggregate as follows:
   a. Sub-base material shall have a maximum particle size of 3-in. in any directions and a nominal size of 2-in.
   b. Use materials with not more than 30 percent by weight of glass. May use a blend of at least 95 percent, by weight, of RCA, and free from organic and other deleterious material. This material shall not contain asphalt or brick.
   c. If RCA is used, provide documentation showing that the material was obtained from a NYSDEC registered or permitted construction and demolition (C&D) debris processing facility as specified in Section 360-16.1 of 6NYCRR Part 360 "Solid Waste Management Facilities" and complying with the regulatory requirements and regulations of Section 31 23 23 – Fill. This material shall be procured from a NYSDOT approved source.
   d. Sub-base material shall meet the specification material requirement and must be able to be placed and fine graded to the required tolerances. Should the sub-base course become unstable at any time prior to the placement of the overlying course, correct the unstable condition to the satisfaction of the Engineer at no additional cost to the City. Perform any required modification prior to placing the material on the grade.
   e. A Geotextile shall be used to separate the sub-grade layer from the sub-base course.
2. Base Course: Binder mixture as specified in the Contract Drawings per NYSDOT Standard Specifications, Sections 401, 402 and 702.
3. Binder Course: Binder mixture as specified in the Contract Drawings per NYSDOT Standard Specifications, Sections 401, 402 and 702.
4. Tack Coat: Asphalt emulsion per NYSDOT Standard Specifications, applied between all HMA pavement lifts prior to placing HMA mixture, per Sections 407 and 702.
5. Top Course: Asphaltic concrete mixture as specified in the contract drawings per NYSDOT Standard Specifications, Sections 401, 402 and 702.

C. Walks: Provide asphaltic pavement for walks conforming to the requirements specified in this section and to the following standards:
1. Bottom Course: Asphaltic concrete mixture, NYSDOT Standard Specifications, Subsections 401-2.01 through 401-2.05, Table 401-1, Type 3
2. Wearing Course: NYSDOT Standard Specifications, Subsections 401-2.01 through 401-2.05, Table 401-1, Type 6F

3. Tack Coat: Asphalt emulsion, NYSDOT Standard Specifications, material designation 702-90

D. Asphaltic concrete shall contain not less than 30 percent reclaimed asphaltic pavement, as measured by weight, in accordance with New York City Local Law 71 of 2011.

E. Traffic and Parking Markings:

1. Colors: As shown on the Contract Drawings and in accordance with the MUTCD.

2. Conform to NYSDOT Standard Specifications Section 727 – Pavement Marking Materials.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Quality Control of Geotextile

1. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP for tests required for the geotextile, at frequency exceeding ASTM D4354, with following minimum acceptable testing frequency:

Property	Test Method	Test Frequency sq m (sq ft)
Grab Tensile Strength	ASTM D4632	1/10,000 (100,000)
Grab Elongation	ASTM D4632	1/10,000 (100,000)
Trapezoidal Tear	ASTM D4533	1/10,000 (100,000)
Mullen Burst	ASTM D3786	1/10,000 (100,000)

2. Conformance Testing:

a. Upon delivery to site, Engineer will remove samples of geotextile and send to laboratory for testing.

b. Testing will be performed at a laboratory accredited by GAI-LAP in accordance with ASTM D4759, Practice A.

B. RCA Material

1. General: Provide materials for sub-base course that consist of sand, gravel, approved blast furnace slag, RCA, or stone that meet the requirements of this specification. Provide materials well graded from coarse to fine, and

free from organic or other deleterious material. Any gravel material will be rejected if it is determined to contain any unsound or deleterious materials.

2. Testing: The Contractor shall retain the services of an independent materials testing laboratory to perform the following laboratory and field tests:

   a. Gradation: Perform sieve analysis in accordance with ASTM/AASHTO procedures C136/T 27, T 88, T 311, T 89 or D 4318/ T 90. Report the following sieves for all tests: #200, #40, ¼ in., ½ in., ¾ in., 1 in., 1 ½ in., 2 in., 3 in.

   b. Soundness: Provide material that complies with the soundness limits specified in the NYSDOT Standard Specifications. Material will be accepted on the basis of Magnesium Sulfate Soundness Loss after four (4) cycles performed according to NYSDOT Standard Specifications.

   c. Plasticity: Determine plasticity using either of the following methods:

      1. Plasticity Index: The Plasticity Index of the material passing the #40 mesh sieve shall meet the values of the Table 1. Determine the plasticity using AASHTO T 89 and ASTM D4318/AASHTO T 90.
      2. Sand Equivalent: The sand equivalence of the granular material shall meet the values in Table 1. Determine sand equivalence using ASTM D2419 or AASHTO T 176.

   d. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a ½-in. sieve shall consist of flat or elongated particles. A flat or elongated particle is defined as one which hast it greatest dimension more than 3 times its least dimension. Acceptance for this requirement will normally be based on a visual inspection. When the Engineer elects to test for this requirement, material with a percentage greater than 30 will be rejected.

   e. Fractured Faces: When the Engineer elects to test for this requirement, Surface material shall have at least two fractured faces on 50 percent of the stone particles larger than ½ in. Base material shall have at least one fractured face on 50 percent of the stone particles larger than ½-in.

3. All materials used in construction, whether brought to the site or developed from on-site sources, shall be tested for gradation, optimum moisture-maximum density curve, and reports of the test results for each source shall be submitted promptly. The tests will be performed in conformance with the procedures contained in the appropriate NYSDOT publications and ASTMs listed in Section 1.04 - References.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. The Resident Engineer shall conduct a pre-pave meeting in accordance with NYSDOT Standards and Specifications Section 402-3.

B. Full Depth Asphaltic Concrete Pavement

1. General: Asphaltic concrete pavement roads shall consist of

a. A layer of woven geotextile fabric,

b. A sub-base course,

c. A base course

d. A tack coat of asphalt emulsion,

e. An intermediate binder course of asphaltic concrete (close binder type),

f. A tack coat of asphalt emulsion, and

g. A top course of fine surface mix asphaltic concrete (top course).

2. Preparation of Subgrade:

a. Per Section 31 23 16 – Excavation, remove to a depth of 24 inches, top soil, boulders, muck, soft clay, spongy material and any other objectionable material and replace them with broken stone, sand and gravel or other approved fill to promote positive drainage.

b. On sites where it appears that there may be some areas containing objectionable materials, proof roll to locate the unsuitable materials.

c. Exercise care during stripping operations to prevent excessive disturbance to subgrade. Use lightweight dozers or grade-alls for low strength, saturated, noncohesive and low cohesive soils.

d. For extremely soft ground such as peat bog areas, do not over excavate surface materials to take advantage of root mat strength.

e. If vegetation is present, cut at ground surface and place sawdust or sand over stumps and roots extending above ground surface.

f. Scrape and fill subgrades, as necessary, and thoroughly consolidate them to the required lines and grades. Consolidate subgrades for pavements by means of a smooth steel-wheel roller having a nominal gross weight of not less than 10 tons, and exerting a minimum force of not less than 300 lbs/in of width on the compression roll faces, or approved equivalent.

g. Compact subgrade to not less than 75 percent relative density as determined by ASTM D4253, or not less than 95 percent of the maximum dry density as determined by ASTM D1557, as applicable.

h. In places where the use of a roller is impractical, compact subgrades with hand tampers weighing not less than 40 lbs. and having a face not exceeding 80 sq.in. in area.

i. Subgrade shall be prepared not less than 100 ft. in advance of the pavement to be immediately constructed.

3. Installation of Geotextile:

a. After subgrade has been prepared, place geotextile in same direction as the new roadway aggregate is being laid down.

b. Do not drag geotextile across subgrade. Place entire roll on subgrade surface and roll out smoothly. Remove wrinkles and folds by stretching and holding down with sandbags as required.

c. Join parallel rolls of geotextile as follows:

California Bearing Ratio (CBR)	Method of Joining
OVER 2	300-450 mm (12-18 in) overlap
1-2	600-900 mm (24-36 in) overlap
0.5-1	900 mm (36 in) overlap or sewn
Less than 0.5	Sewn
All roll ends	900 mm (36 in) overlap or sewn

d. If the CBR of the subgrade is not known, join parallel rolls by sewing them together.

e. For subgrades with CBR less than or equal to 1, where the geotextile is to provide reinforcement, the geotextile shall be pretensioned in the following manner:

1) Proofroll with heavily loaded, rubber-tired vehicle. Wheel load of truck shall be equivalent to maximum expected for site. Vehicle to make at least four passes over first lift in each area of site.

2) Once design aggregate has been placed, use roadway prior to paving to prestress geotextile-aggregate system.

f. If required, the geotextile may be held in place prior to subbase placement with sandbags. The use of pins to anchor the geotextile will not be permitted, except at edges of existing pavement as specified below.

g. Do not place overlaps along anticipated primary wheel path locations. Place overlaps at end of rolls in direction of aggregate placement with previous roll on top.

h. When sewn seams are required, strength of seams shall be greater than or equal to 80 percent of tensile strength of unseamed geotextile as determined by same testing methods.

i. When placing woven geotextile on curves, fold or cut geotextile and overlap in direction of turn with previous fabric on top. Staple or pin folds in geotextile approximately 2 ft on center.

j. When geotextile intersects an existing pavement area, extend geotextile to edge of old system and anchor it by trenching and covering the edge of the fabric with stone, or staple or pin the fabric to the ground. For widening or intersecting existing roads where geotextiles have been used, excavate edge of roadway down to existing geotextile and sew the new geotextile to the existing geotextile, or overlap and staple or pin the new fabric to the old and into the ground.

k. Prior to covering, inspect geotextile for excessive damage, including holes, rips and tears.

    1) If excessive defects are observed, repair affected area by placing new layer of geotextile over damaged area.

    2) Extend new layer beyond damaged area the same distance as required for overlap of adjacent rolls.

l. End-dump base aggregate on previously placed aggregate. End dumping or tail-gate dumping of the aggregate directly on the geotextile will not be permitted.

    1) For subgrades with CBR less than or equal to 1, limit pile heights to prevent possible subgrade failure.

    2) Maximum placement thickness for subgrades with CBR less than or equal to 1 shall not exceed design thickness of road.

m. Spread and grade first lift of aggregate to 12 in. or to design thickness if less than 12 in. prior to compaction. Do not allow traffic on soft roadway with less than 8 in. of aggregate over geotextile, except 6 in. for CBR greater than or equal to 3.

n. Compact the sub-base course as specified in Paragraph D.2. Vibratory compaction shall not be used on the initial lift over the geotextile.

o. Perform construction parallel to road alignment.

p. Fill ruts formed during construction to maintain adequate cover over geotextile. Do not blade ruts down.

q. Place remaining base aggregate in lifts not exceeding 250 mm (10 in) in loose thickness and compact to specified density.

r. Equipment may operate on roadway without aggregate for geotextile installation under permeable bases if subgrade is of sufficient strength.

1) For soils with CBR less than or equal to 0.5, use lightweight construction vehicles for access on first lift.

2) Limit construction vehicles in size and weight to limit rutting in initial lift to 3 in.

3) If rut depths exceed 3 in, decrease construction vehicle size or weight or increase lift thickness.

s. Turning will not be permitted on first lift of base aggregate. Construct turn-outs at roadway edge to facilitate construction.

4. Sub-Base Course:

a. Spreading

1) Spread the No. 1 and No. 2 stone or RCA uniformly on the geotextile with shovels from piles along the side of the roadway or from dumping boards or by means of vehicles of approved design constructed especially for this purpose, but in no case dump the material directly on the geotextile.

2) The loose lift thickness shall be a minimum of 1.5 times the maximum particle size. The Contractor shall control the lift thickness, provided that the thickness shall not exceed the thickness limitations specified herein, for installation of aggregate over geotextile, and shall not exceed the maximum allowed according to the equipment classifications in Subparagraph 2, *Compaction Equipment* of Subsection 203-3.03.C, Compaction, of New York State Department of Transportation Standard Specifications, and the equipment meets all specified class criteria of that Standard.

3) Spread broken stone or RCA in sufficient quantity to provide the required thickness after rolling. The depth of stone shall

be gauged by the use of cubical concrete blocks of the required thickness, or other approved means.

4) Remove all segregated fine or coarse stone and replace it with well graded stone.

5) Do not spread the broken stone or RCA over wet geotextile.

6) Do not place broken stone or RCA adjacent to manhole heads or other structures until such structures have been set to the required lines and grades.

b. Rolling and Filling

1) After the No. 1 and No. 2 stone or RCA mixture has been laid loose, thoroughly roll it with an approved smooth steel-wheel roller having a nominal gross weight of not less than 10 tons and exerting a minimum force of 300 lbs/in of width on the compression roll faces.

2) Start rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half the width of a rear wheel. A minimum of 8 passes shall be applied over each lift with the roller operating at a speed not exceeding 6 feet per second. Rolling shall be continued until there is no movement of the stone ahead of the roller.

3) After the sub-base is thoroughly compacted, as measured by the method described in Paragraph f, below, uniformly spread No. 4 stone over the compacted area from piles along the side of the roadway or from dumping boards. Broom the filler in and roll it dry until no more filler can be forced into the voids. Remove excess filler.

4) Do not lay over 500 lineal feet of the sub-base without it being rolled and thoroughly filled.

5) The maximum layer thickness prior to compaction shall be 12 in., and the final compacted thickness shall be as shown on the Contract Drawings. In confined areas as defined by the Engineer the maximum compacted layer thickness shall be 6 in.

6) Do not allow the surface of the completed sub-base to deviate more than ¼ inch in 5ft from the nearest point of contact nor more than 3/8-in in 18ft when tested by means of an 18ft straight-edge placed parallel to the centerline of the roadway.

7) If any irregularities develop in the surface during or after rolling of the sub-base, remedy them by loosening the

surface and removing or adding broken stone or RCA as may be required, and follow by rolling the entire area, including the surrounding surface, applying filler and continuing rolling until the course is compacted satisfactorily to a uniform surface.

5. Base and Binder Courses:

   a. Preparation: Clean the binder course of all dirt and loose material, thoroughly dry it and obtain the Resident Engineer's approval before laying the binder course.

   b. Weather Limitations: Bituminous material or mixture shall not be applied on any soft surfaces, when the surface is wet, when the temperature of the surface on which the mixture is to be placed is below 45°F, or when other weather conditions would prevent proper construction of the pavement.

   c. Forms: When side forms are required, accurately set them to line and grade and securely stake and brace them in place sufficiently to withstand all construction operations. Thoroughly clean and oil forms before use.

   d. Spreading:

      1) Dump the binder course into the hopper of the spreader. Spread and screed it immediately to the full width required for the pavement and to such a depth that, when rolled, the required thickness is obtained. The maximum allowable compacted thickness for binder shall be 4 in. The maximum allowable compacted thickness for base shall be 6in.

      2) When the mixture is to be spread by hand, dump it on approved steel dump sheets outside of the area on which it is to be spread and immediately distribute it into place and spread it in a uniformly loose layer.

      3) Remove material from areas which show an excess or lack of bituminous material or an inconsistent mix and fill with new material. Re-spread or otherwise rectify areas which show segregation to obtain a uniform mixture in the course.

      4) Do not use mixture which has been over 45 minutes out of the mixer, or if longer, the mixture must be over 250°F when spread.

      5) Do not lay over 500 lineal feet of binder material without it being rolled and properly compacted.

   e. Compacting:

1) 50 Series Compaction Method: Contractor shall compact HMA according to NYSDOT Standard Specifications Section 402-3.07A.

2) 60 Series Compaction Method: Contractor shall compact HMA according to NYSDOT Standard Specifications Section 402-3.07B.

3) 70 Series Compaction Method: Contractor shall compact HMA according to NYSDOT Standard Specifications Section 402-3.07C.

4) 80 Series Compaction Method: Contractor shall compact HMA according to NYSDOT Standard Specifications Section 402-3.07D.

6. Tack Coat:

a. Before spreading the binder course, spray the sub-base with an asphalt emulsion tack coat in the amount of 0.25 gallon per square yard. Allow the tack coat to cure until sticky or tacky. Renew and repair or replace damaged coating.

b. Tack coat shall be applied evenly by means of a truck having appropriate spray nozzles. All nozzles shall be kept free of clogs.

c. Paint contact surfaces of all curbing, gutters, manholes and adjacent pavement edges with the tack coat material.

d. Tack coat shall not be applied on a wet pavement surface or when the temperature is below 45° F.

e. Tack coat shall be applied between all HMA pavement lifts prior to placing HMA mixture.

7. Top Course:

a. Preparation:

1) Thoroughly clean the binder course of all loose and foreign material before the top mixture is delivered.

2) Apply a tack coat at a rate of 0.03 to 0.07 gallon per square yard as approved by the Engineer.

3) Do not lay mixture until the Engineer approves the binder course and determines in all cases whether the weather conditions are suitable to permit laying.

b. Weather Limitations: Bituminous material or mixture shall not be applied on any soft surfaces, when the surface is wet, when the temperature of the surface on which the mixture is to be placed is below 45° F, or when other weather conditions would prevent proper construction of the pavement

c. Forms: If at the time of laying the mixture, permanent side supports such as curbs, edgings or gutters have not been constructed, firmly fasten in place suitable side forms of wood or steel, true to line and grade. In all cases adequately support the sides of roadways until final compaction has been obtained and the mixture has hardened by cooling.

d. Spreading and Compacting:

1) Spread and compact the top course until it meets the compaction and surface requirements specified above for the binder course.

2) The Contractor shall have the same options for achieving the required compaction as given for the compaction of the binder course.

3) Do not lay over 500 lineal feet of top course material without it being rolled and properly compacted.

4) Do not use mixture which has been over 45 minutes out of the mixer, or if longer, the mixture must be over 250° F when spread.

e. Joints: Perform construction as near continuously as possible. Carefully make joints between old and new pavements, or between successive days' work, in a manner which will insure a thorough and continuous bond, as follows:

1) Cut back the edge of the old surface before recommencing the operation of laying, in order to present a fresh, clean surface for contact with the newly placed material.

2) Carefully employ hot smoothing irons to heat the old pavement sufficiently (without burning) to insure a proper bond.

f. Shoulders: If temporary forms are used, protect the edges of the finished roadway by placing and thoroughly compacting approved material to form shoulders along the roadway as shown on the Contract Drawings. Construct finished shoulders 1/4 inch above the elevation of the finished roadway edges.

g. If weather conditions necessitate delaying the installation of the top course for more than two days, the tack coat shall be reapplied to the binder course at the rate of 0.03 to 0.07 gallon per square yard as approved by the Engineer.

C. Mill and Overlay

1. Conform to NYSDOT Standard Highway Specifications, Section 490 for cold milling of existing pavement.

2. Milling shall conform to Section 02 41 10 – Demolition and Removals.

3. Conform to NYSDOT Standard Highway Specifications, Section 401, 402 and 702 for new top course.

4. Mill to the thickness shown in the Contract Drawings or as directed by the Engineer.

5. Follow requirements for Top Course as specified herein.

D. Walks

1. General: Asphaltic concrete pavement walks shall consist of

   a. A binder course of asphaltic concrete (close binder type),

   b. A tack coat of asphalt emulsion, and

   c. A top course of fine surface mix asphaltic concrete.

2. Binder Course:

   a. Before the binder course is laid:

      1) Compact the subgrade thoroughly, so that the binder course, after compaction, will be found satisfactory when field tested.

      2) Clean subgrade of all loose and foreign material, dry it, and obtain the Resident Engineer's approval.

   b. Paint contact surfaces of all curbing, gutters, manholes and adjacent pavement edges with an asphalt emulsion tack coat at the rate of 0.03 to 0.07 gallon per square yard as approved by the Resident Engineer.

   c. Set forms, spread and compact the binder course as specified above for the binder course for roads.

   d. Provide a binder course surface free from depressions exceeding 3/8-inch when tested with a 10-foot straight edge placed parallel with the center line of the walk.

3. Top Course:

   a. Clean the binder course of all loose and foreign material before the top course mixture is delivered. Do not lay mixture until the Resident Engineer approves the binder course and determines in all cases whether the weather conditions are suitable to permit laying.

   b. If at the time of laying the mixture, permanent side supports such as curbs, edging or gutters have not been constructed, fasten in place suitable side forms of wood or steel, true to line and grade. In all cases, adequately support the sides of walks until final compaction is obtained and until the mixture hardens.

c. Spread and compact the top course as specified for the binder course.

d. Provide a walk surface free from depressions exceeding 1/8-inch when measured with a 10-foot straight edge placed parallel with the centerline of the walk.

e. Perform construction as near continuously as possible. Carefully make joints between old and new pavements, or between successive days' work, in a manner which will insure a thorough and continuous bond, as follows:

1) Cut back the edge of the old surface before recommencing the operation of laying, in order to present a fresh, clean surface for contact with the newly placed material.

2) Carefully employ hot smoothing irons to heat the old pavement sufficiently (without burning) to insure a proper bond.

f. Paving procedure, including compaction requirements, shall be the same as specified above for the top course for roads.

E. Patching

1. As directed by Resident Engineer, remove and replace defective areas. Cut such areas and replace with fresh asphaltic concrete and compact to required density.

F. Pavement Marking

1. Clean with power and hand brooms.

2. Mark edges straight and uniform. Use two coats and comply with manufacturer's recommendations.

G. Pavement Restoration

1. Pavement restoration of Westchester County roads, including but not exclusive to Columbus Ave, shall be performed in accordance with Part VI, Section 813.51 of the Westchester County Code of Ordinances.

2. Pavement restoration of Town of Mount Pleasant Roads shall be performed in accordance with the Code of the Town of Mount Pleasant Section 188-7.

3.03 FIELD TESTING / QUALITY CONTROL

A. Pavement Density Testing/Monitoring

1. Contractor shall conduct the following pavement density monitoring operations depending on the pavement design compaction series indicated in the Contract Drawings:

a. 50 Series Compaction: Contractor shall extract pavement cores, in accordance with NYSDOT Section 402-3.08A, and deliver to the Regional Materials Laboratory in accordance with NYSDOT standard specifications Section 402-3.08E, for density testing.

b. 60 Series Compaction: Contractor shall monitor pavement density using density gauges in accordance with NYSDOT Standard Specifications Section 402-3.07B. The density gauges used to monitor pavement density shall follow the requirements specified in NYSDOT Standard Specification Section 402-3.07E. In addition to density gauge measurements, contractor shall extract pavement cores, in accordance with NYSDOT Standard Specifications Section 402-3.08A, and deliver to the Regional Materials Laboratory in accordance with NYSDOT Standard Specifications Section 402-3.08E, for density testing.

c. 70 Series Compaction: Contractor shall monitor pavement density using density gauges in accordance with NYSDOT Standard Specifications Section 402-3.07C. The density gauges used to monitor pavement density shall follow the requirements specified in NYSDOT standard specification section 402-3.07E.

d. 80 Series Compaction: Density testing is not required. Contractor shall place and compact HMA as per NYSDOT Standard Specifications Section 402-3.07D.

2. When required by the Engineer, furnish 4-inch diameter test samples cored from the binder course and from the completed pavement. The Engineer will choose the number of cores and the locations at which the cores shall be taken. Sample cores, when required, shall be taken for every 10,000 square feet of pavement and patch. Density test shall show that the sample is within 90 percent of the laboratory specimen. Replace with new mixture and refinish the areas of pavement so removed without additional compensation.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning and Protection

1. After paving, clear surfaces of excess asphaltic concrete and all foreign matter.

2. Protect new pavement until fully hardened.

3. Cover openings of drainage structures until permanent covers are placed.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, and equipment required to install all reinforced turf, as shown, specified, and required.

B. Section includes:

1. Reinforced Turf

a. Recycled Plastic Reinforced Turf System, assembled in rolls

b. Engineered sand and gravel base course

c. Fertilizer: formulated growth enhancer

d. Sand fill

e. Selected grass from seed, hydroseeding/hydro-mulching, or sod

f. Selected topsoil

g. Mulch

C. The Contractor shall implement practices and procedures to meet the Project's sustainability goals as identified in the Contract Documents. The Contractor shall ensure that the sustainability requirements of this Section are implemented to the fullest extent.

D. The following index of this Section is presented for convenience:

E.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 31 23 16 - Excavation

B. Section 31 23 23 - Fill

C. Section 32 90 00 - Planting

1.04 REFERENCES

A. AASHTO M6 – Standard Specification for Fine Aggregate for Hydraulic Cement Concrete

B. ASTM C29 - Bulk Density and Voids in Aggregate Materials

C. ASTM C33 - Standard Specification for Concrete Aggregates

D. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

E. ASTM D638-10 – Standard Test Method for Tensile Properties of Plastics

F. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction

G. ASTM F1632-03 – Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes.

1.05 DESCRIPTION

A. Sustainable Design Requirements

1. Regional Materials: Reinforced Turf shall be manufactured within 500 miles of Project Site.

1.06 QUALITY ASSURANCE

A. Utilize a manufacturer having at least ten years of experience manufacturing interlocking Recycled Plastic Reinforced Turf System on projects of similar nature or project size.

B. Source Limitations:

1. The Porous paver system shall be provided through a single vendor with products of consistent quality in appearance and physical quality.

C. Paving Contractor Qualifications:

1. Utilize an installer having successfully completed Recycled Plastic Reinforced Turf System installation similar in design, material, and extent indicated on this Project.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and manufacturer's technical information for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's catalog product data
2. Certification indicating porous pavement meets HS-20 loading requirements per AASHTO
3. Installation instructions
4. Material safety data sheets
5. Details and cross-sections

B. Paving Installation Contractor:

1. Job references from a minimum of three projects similar in size and complexity. Provide names, postal address, phone, and email address.

C. Recycled Plastic Reinforced Turf System :

1. Manufacturer signed certificate stating the product is made in the USA.
2. Submit Material Certificates for base course and gravel fill materials.
3. Product certificates signed by the manufacturer certifying material compliance of polyethylene used to make Reinforced Turf units.
4. ISO Certificate certifying manufacturer's quality management system is currently registered to ISO 9001:2008 quality standards.

D. Sustainable Design Submittals:

1. Environmental Materials Reporting Form (EMRF) Regional Materials. Provide the following information:
    a. Name of Product and Manufacturer.
    b. Material cost breakdowns. Cost breakdowns must include total material-only cost (excluding installation, labor and equipment).
    c. Indicate the location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. For assemblies, include the percentage by weight that is considered regional.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver reinforced turf in manufacturer's original, unopened, and undamaged container packaging with identification labels intact. Store and handle reinforced turf and related materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage, chipping, or other causes.

B. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to reinforced turf installation.

C. Deliver reinforced turf to the Site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.

D. Protect reinforced turf system units/rolls from damage during delivery and store rolls upright, under tarp, to protect from sunlight, when time for delivery to installation exceeds one week.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Porous Pavement
    1. Invisible Structures, Inc., Aurora, CO
    2. Boddingtons, Berry Global, Old Hickory, TN
    3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Recycled Plastic Reinforced Turf System

1. Reinforced Turf Unit Type:

a. Composition:

1) Manufactured in the USA

2) High density polyethylene (HDPE): 100 percent recycled materials

3) Color: black

4) Color Uniformity: Uniform color throughout all units' rolls.

5) Carbon Black for ultraviolet light stabilization.

6) Fertilizer

b. Performance Properties:

1) Maximum Loading Capability: 15,940 psi (2.29 million psf, 109,906 kPa) when filled with sand

2) Tensile strength, pull-apart testing: 458 lbf/in from ASTM D638 Modified

3) System Permeability (Reinforced Turf, sand, base course): 2.63 to 38.55 inches of water per hour.

4) Effective Imperviousness: 10%

c. Dimensions:

1) Roll area: from 108 sq ft to 538 sq ft, in 108 sq ft increments

2) Roll widths: from 3.3 ft to 8.2 ft, in 1.6 ft increments

3) Roll lengths: from 32.8 ft to 65.6 ft, in 3.3 ft increments

4) Roll weights: from 41 lbs to 205 lbs, in 41 lbs increments

5) Unit Nominal Width by Length: 20 inches by 20 inches or 40 inches by 40 inches

6) Nominal Depth: 1 inch – for rolls and individual units.

7) Unit Weight: 18 oz or 5 lbs

8) Volume Solid: 8 percent

2. Reinforced turf Base Course: Sandy gravel material from local sources commonly used for road base construction

    a. Conforming to the following sieve analysis and requirements (recycled materials such as crushed concrete or crushed asphalt are not acceptable):

        1) 100 percent passing sieve size 1 inch (25 mm).

        2) 80-100 percent passing sieve size 3/4 inch (19 mm).

        3) 60-80 percent passing sieve size 3/8 inch (9 mm).

        4) 40-60 percent passing sieve size #4.

        5) 25-40 percent passing sieve size #10.

        6) 5-25 percent passing sieve size #40.

        7) 0-5 percent passing sieve size #200.

    b. Provide a base course material nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.

    c. Material may be either "pit run" or "crusher run." Avoid using clay-based crusher run/pit run. Crusher run material will generally require coarse, well-draining sand conforming to ASTM F1632-03, AASHTO M6 or ASTM C33 to be added to mixture (20 to 30 percent by volume) to ensure long-term porosity and are brought to proper compaction.

    d. Alternative materials such as crushed sell, limerock, or crushed lava may be used for base course use, provided they are mixed with sharp sand (20 to 30 percent) to ensure long-term porosity and are brought to proper compaction.

3. Reinforced turf Sand Fill for Rings and Spaces Between Rings: Clean sharp sand (washed concrete sand).

    a. Coarse, well-draining sand, such as washed concrete sand conforming to ASTM F1632-03, AASHTO M6 or ASTM C33.

4. Reinforced Turf Conditioner:

    a. Fertilizer, formulated growth enhancer.

5. Reinforced Turf Grass:

    a. Seed: Use seed materials, of the preferred species for local environmental and projected traffic conditions, from certified sources. Seed shall be provided in containers clearly labeled to show

seed name, lot number, net weight, % weed seed content, and guaranteed % of purity and germination. Pure Live Seed types and amount shall be shown on plan.

1) Mulch – needed only for hydroseeding: wood or paper cellulose commercial mulch materials compatible with hydroseeding operations. Mulch depth according to mulch manufacturers' recommendation. Do not use mulch of straw, pine needles, etc., because of their low moisture holding capacity.

2) Topsoil – needed only for seeding, recommended for hydroseeding: obtain specified topsoil for a light "dusting" (no more than ½") above rings filled with sand for seeding germination.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Contractor shall examine all surfaces to receive paving and correct all conditions which are not in compliance with the requirements specified herein, or which are unsatisfactory in any way. It shall be the responsibility of the Contractor to ensure that all footings, and all subgrades, bases and surfaces to receive paving, are clean, level and adequately prepared.

B. Preparation for Reinforced Turf

1. Verify subgrade in accordance with reinforced turf system manufacturer's instructions. The existing subgrade shall be compacted to 80 percent Modified Proctor in 8 inches lifts and shall not be subject to excessive construction equipment traffic prior to engineered base placement.

2. Excavate area allowing for unit thickness, the engineered base depth and 0.5 inch for depth of topsoil germination area.

3. Provide adequate drainage from excavated area if area has potential to collect water, when working with in-place soils that have poor permeability.
4. Ensure in-place soil is relatively dry and free from standing water.
5. Uniformly grade base.
6. Level and clear base of large objects, such as rocks and pieces of wood.
7. For fire lane installations: prior to installing base course for turf paving, obtain approval of local fire authorities of sub-base.
8. Verify engineered base is installed in accordance with reinforced turf system manufacturer's instructions.
9. Coordinate base installation and preparation with subdrains.
10. Place a geotextile separation layer between the natural ground and the engineered base.
11. Install the specified sub-drain and outlet according to construction drawings.
12. Coordinate base installation and preparation with irrigation and drip irrigation lines.
13. Place engineered base in lifts not to exceed 6 inches, compacting each lift separately to 95 percent Modified Proctor.
14. Leave 1 inch of depth below final grade for reinforced turf unit and sand fill and 0.5 inch for depth of sod root zone or topsoil germination area.
15. A qualified Manufacturer's field representative shall be available for a pre-construction meeting via phone or in person and will provide installation videos, design details, installation instructions, and the technical specifications. The time for on-site observation shall be indicated in the Contract Documents and included in the base bid price.

3.02 INSTALLATION

A. Fertilizer

1. Spread all Fertilizer mix provided (spreader rate = 10 lbs per 1076 sq. ft) evenly over the surface of the base course with a hand-held, or wheeled rotary spreader.
2. The Fertilizer mix should be placed immediately before installing the porous pavement units.

B. Reinforced Turf

1. Install the reinforced turf units by placing units with rings facing up, and using snap-fit connectors, pegs and holes, provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves, slopes, and high traffic areas shall be anchored to the base course, using 40d common nails with fender washer, as required to secure units in place. Tops of rings shall be between 0.25" to 0.5" below the surface of adjacent hard-surface pavements.
2. Install sand in rings as they are laid in sections by "back-dumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the Site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 0.25" above top of rings.

C. Grass for Porous Pavement

1. Grass coverage on the sand-filled rings must be completed within one week. Sand must be re-installed and leveled and Reinforced Turf checked for integrity if rings become exposed due to wind, rain, traffic, or other factors.
    a. Hydroseeding/hydro-mulching - A combination of water, seed and fertilizer are homogeneously mixed in a purpose-built, truck-mounted tank. The seed mixture is sprayed onto the Site at rates shown on plans and per hydroseeding manufacturer's recommendations. Coverage must be uniform and complete. Following germination of the seed, areas lacking germination larger than 8" x 8" must be reseeded immediately. Seeded areas must be fertilized and kept moist during development of the turf plants. Do not drive on system. Hydroseeded/hydro-mulch areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Reinforced Turf system.
    b. Install grass seed at rates per grass type. A light "dusting" of commercial topsoil mix, not to exceed ½” will be placed above the rings and seed mix to aid germination rates. Seeded areas must be fertilized and kept moist during development of the turf plants. Do not drive on system. Seeded areas must be protected from any traffic, other than emergency vehicles, for a period of 6 to 8 weeks, or until the root system has penetrated and established well below the Reinforced Turf system.

2. Adequately water grass seed to assure germination of seed and growth of root system.

3.03 FIELD TESTING / QUALITY CONTROL

A. Remove and replace segments of porous pavement units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjustments

1. Remove and replace defective, broken or damaged paver units or system components, including but not limited to the following defects:

a. Not matching approved samples

b. Broken, chipped, stained, or otherwise damaged

c. Defective setting beds

d. Uneven settling, or other evidence of improper bedding or alignment

e. All other defects as directed by the Engineer

B. Protection

1. Seeded areas shall be protected from any traffic, other than emergency vehicles, for a period of 4 to 8 weeks, or until the grass is mature to handle traffic.

2. The Contractor shall maintain all paving during the life of this Contract until Substantial Completion of the Work and shall repair and replace all Work that is disturbed, damaged, or destroyed without additional payment.

a. Maintenance of Porous Pavement

1) Maintain grass in accordance with manufacturer's instructions and as specified in Section 32 92 00 – Planting.

2) Normal turf care procedures should be followed, including de-thatching.

3) Do not aerate.

4) When snow removal is required, keep a metal edged plow blade a minimum of ¾ inch above the surface during

plowing operations to avoid causing damage to the porous pavement units or

a) Use a plow blade with a flexible rubber edge or

b) Use a plow blade with skids on the lower outside corners set so the plow blade does not come in contact with the units.

C. Clean-Up

After completion of the Work, the Contractor shall remove all debris and excess materials, restore all damaged areas and leave the area in a clean state acceptable to the Engineer.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment required to install all permeable pavers, as shown, specified and required.

B. Section includes:

1. Permeable Pavers

a. Permeable Concrete Pavers

b. Permeable Joint Opening Aggregate

c. Permeable Joint Aggregate Type 1

d. Permeable Joint Aggregate Type 2

e. Permeable Setting Bed Aggregate (Open-graded)

f. Permeable Base Aggregate (Open-graded)

g. Permeable Subbase Aggregate (Open-graded)

C. The Contractor shall implement practices and procedures to meet the Project's sustainability goals as identified in the Contract Documents. The Contractor shall ensure that the sustainability requirements of this Section are implemented to the fullest extent.

D. The following index of this Section is presented for convenience:

E.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete

B. Section 31 05 19 – Geosynthetics for Earthwork

C. Section 31 23 16 - Excavation

D. Section 31 23 23 - Fill

E. Section 32 90 00 – Planting

F. Section 33 05 05 – Buried Piping Installation

1.04 REFERENCES

A. ASTM C29 - Bulk Density and Voids in Aggregate Materials

B. ASTM C33 - Standard Specification for Concrete Aggregates

C. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

D. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

E. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction

F. ASTM C936 - Standard Specification for Solid Concrete Interlocking Paving Units

G. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete

H. ASTM C1645 - Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Interlocking Paving Units

I. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

J. ASTM D4533 - Standard Test Method for Index Trapezoidal Tearing Strength of Geotextiles

K. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

L. ASTM D4491 - Standard Test Method for Water Permeability of Geotextiles by Permittivity

M. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile

1.05 DESCRIPTION

A. Sustainable Design Requirements

1. Regional Materials: Pavers shall be manufactured within 500 miles of Project site.

1.06 QUALITY ASSURANCE

A. Utilize a manufacturer having at least ten years of experience manufacturing interlocking concrete pavers on projects of similar nature or project size.

B. Source Limitations:

1. The Permeable paver system shall be provided through a single vendor with products of consistent quality in appearance and physical quality.

2. Obtain Permeable Joint Opening Aggregate from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.

C. Paving Contractor Qualifications:

1. Utilize an installer having successfully completed permeable paver installation similar in design, material, and extent indicated on this Project.

D. Permeable Paver Mockups:

1. Install a 5 ft by 5 ft paver area.

2. Use this area to determine joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.

3. Subject to acceptance by owner, mock-up may be retained as part of finished work.

4. If mock-up is not retained, haul offsite and dispose legally.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and manufacturer's technical information for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's catalog product data

2. Certification indicating permeable pavers meets HS-20 loading requirements per AASHTO

3. Installation instructions

4. Material safety data sheets

5. Details and cross-sections

6. Paving Installation Contractor:

7. Job references from a minimum of three projects similar in size and complexity. Provide names, postal address, phone, and email address.

B. Permeable Concrete Pavers:

1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon Project completion.

2. Accepted samples become the standard of acceptance for the product produced.

3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.

C. Permeable Joint Opening Aggregate:

1. Provide three representative one-pound samples in containers of aggregate materials that indicate the range of color variation and texture expected upon Project completion.

2. Accepted samples become the standard of acceptance for the product produced.

3. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C136.

4. Test results for void space percentage per ASTM C29.

D. Permeable Setting Bed, Base and Subbase Aggregate:

1. Test results from an independent testing laboratory for compliance with ASTM D448 No. 8, No. 57 and No. 2.

2. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C136.

3. Test results for void space percentage per ASTM C29.

E. Sustainable Design Submittals:

1. Environmental Materials Reporting Form (EMRF) Regional Materials. Provide the following information:

a. Name of Product and Manufacturer.

b. Material cost breakdowns. Cost breakdowns must include total material-only cost (excluding installation, labor and equipment).

c. Indicate the location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. For assemblies, include the percentage by weight that is considered regional.

F. Maintenance Submittals:

1. The equipment information, operating procedures including disposal, and schedule for maintenance work must be submitted at least 45 calendar days prior to the start of maintenance and cleaning.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact. Store and handle pavers and related materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage, chipping, or other causes.

B. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.

C. Deliver permeable pavers to the Site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.

D. Unload pavers in such a manner that no damage occurs to the product or adjacent surfaces.

E. Do not use pinch or wrecking bars. Lift with wide-belt-type slings where possible. Do not use wire rope or ropes containing tar or other substances which might cause

staining. If required to move pavers, use wood rollers with cushions at end of wood slides.

F. Store pavers on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and pavers to distribute weight evenly and to prevent breakage or cracking. Allow air circulation around pavers. Store cementitious materials off the ground, under cover and in a dry location.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Permeable Pavers

1. Unilock, Brewster, NY
2. Techo-Bloc Corp, Pen Argyl, PA
3. Or approved equal.

B. Geotextile

1. Carthage Mills – FX-40HS
2. U.S. Fabrics – US 115NW
3. Mirafi – 140N
4. Or approved equal.
5. Edge Restraints
6. Permaloc - No.: 3 inch GeoEdge
7. SEK Surebond - No.: 8 feet PermEdge
8. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Permeable Pavers:

1. Permeable Paver Type:

a. All pavers shall conform to the following requirements:

b. Finish: Standard

c. Color:

d. Edge: Chamfer – 3 mm bevel

e. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.

1) L-shape

2. Provide pavers meeting the minimum material and physical properties set forth in ASTM C936. Efflorescence is not a cause for rejection.

a. Average compressive strength 8000 psi (55 MPa) with no individual unit under 7200 psi (50 MPa).

b. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C140.

c. Conforming to ASTM C1645 when tested for freeze-thaw requirements.

d. Height tolerances +/- 3.2 mm (1/8 in).

3. Accept only pigments in concrete pavers conforming to ASTM C979.

4. Maximum allowable breakage of product is 5%

B. Permeable Joint Opening Aggregate

1. Provide Permeable Joint Opening Aggregate materials conforming to ASTM C33 and gradation requirements as shown in Table 1.

Table 1 - Permeable Joint Opening Aggregate Gradation Requirements (Granite Chips)

1/8 to 3/16 inch granite chips	
Sieve Size	Percent Passing
1/4 in (6 mm)	97 to 100
No. 4 (4.75 mm)	70 to 83
No. 8 (2.36 mm)	37 to 50
No. 16 (1.18 mm)	0 to 12

C. Permeable Setting Bed Aggregate

1. Provide Permeable Setting Bed Aggregate materials conforming to ASTM C33 and gradation requirements of ASTM D448 No. 8 as presented in Table 2.

Table 2 - Permeable Setting Bed Aggregate Gradation Requirements

ASTM No. 8

Sieve Size	Percent Passing
1/2 in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

D. Permeable Base Aggregate

1. Provide Permeable Base Aggregate materials conforming to ASTM C33 and gradation requirements of ASTM D448 No. 57 as presented in Table 3.

Table 3 - Permeable Base Aggregate Gradation Requirements

ASTM No. 57	
Sieve Size	Percent Passing
1/2 in (12.5 mm)	100
3/8 in (9.5 mm)	95 to 100
No. 4 (4.75 mm)	25 to 60
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

E. Permeable Subbase Aggregate

1. Provide Permeable Subbase Aggregate materials conforming to ASTM C33 and gradation requirements of ASTM D448 No. 2 as presented in Table 4.

Table 4 - Permeable Subbase Aggregate Gradation Requirements

ASTM No. 2	
Sieve Size	Percent Passing
1/2 in (12.5 mm)	100
3/8 in (9.5 mm)	90 to 100
No. 4 (4.75 mm)	35 to 70
No. 8 (2.36 mm)	0 to 15
No. 16 (1.18 mm)	0 to 5

F. Geotextile

1. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:

   a. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

   b. Grab Tensile Strength: ASTM D4632: 115 lbs.

c. Grab Tensile Elongation: ASTM D4632: 50%

d. Trapezoidal Tear: ASTM D4533: 50 lbs.

e. Puncture: ASTM D4833: 65 lbs.

f. Apparent Opening Size: ASTM D4751: 0.212 mm, 70 U.S. Sieve

g. Permittivity: ASTM D4491: 2.0 sec -1

h. Flow Rate: ASTM D4491: 140 gal/min/s.f.

G. Edge Restraints

1. Concrete Edge Restraint as indicated.

2. Plastic and Metal Edge Restraints as indicated.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Contractor shall examine all surfaces to receive paving and correct all conditions which are not in compliance with the requirements specified herein, or which are unsatisfactory in any way. It shall be the responsibility of the Contractor to ensure that all footings, and all subgrades, bases and surfaces to receive paving, are clean, level and adequately prepared.

B. Preparation for Permeable Paver

1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.

a. The existing subgrade under the paver subbase should not be compacted or subject to excessive construction equipment traffic.

b. Where erosion has caused accumulation of sediment or ponding on the subgrade, remove sediment with light equipment and/or manually. Scarify the underlying soils to a minimum depth of six inches with a York-type rake or equivalent equipment to the satisfaction of the Engineer.

c. Restore any subgrade areas damaged by erosion, ponding, or traffic compaction to design grades prior to installation of the paver system.

d. Any excess thickness of material placed over the soil subgrade to trap sediment transported by runoff from adjacent construction areas must be removed prior to installation of the paver system.

2. Verify that Geotextiles have been placed according to drawings and Specifications.

3. Verify that Permeable Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.

4. Provide written density test results for soil subgrade, Permeable Base and Subbase Aggregate materials.

5. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.

6. Remove any standing water from subgrade soil, if necessary.

7. Stockpile Permeable Setting Bed, Joint, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

8. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Permeable Subbase Aggregate materials.

9. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Permeable Joint, Setting Bed, Base and Subbase Aggregate materials contaminated with sediment and clean materials.

10. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Permeable Subbase Aggregate construction.

11. Prevent damage to underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation.

3.02 INSTALLATION

A. Edge Restraints

1. Provide edge restraints as indicated.

a. Install concrete edge restraints in accordance with the requirements of Section 03 30 00 - Cast-in-Place Concrete

b. Provide concrete edge restraint along the perimeter of all paving as specified. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.

c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in thick.

2. Provide plastic or metal edge restraints as indicted.

a. Provide plastic or metal edge restraints along the perimeter of all paving as indicated and supported on a minimum of 6 inches of Base Aggregate.

b. Provide 10” spiral galvanized or stainless-steel spike to fasten plastic edge restraint at 24 inches on center for straight sections and 12 inches on center for curved sections.

B. Geotextiles

1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.

2. Overlap ends and edges a minimum of 18 in. in the direction of drainage.

C. Permeable Base and Subbase Aggregate

1. Subgrade shall be level and uncompacted.

2. Clean by washing and provide the Permeable Subbase Aggregate and Permeable Base Aggregate in uniform lifts not exceeding 8in. loose thickness and compact if necessary.

3. Compact the Permeable Subbase Aggregate and Permeable Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10-ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.

4. Tolerance:

a. Do not exceed the specified surface grade of the compacted Permeable Subbase Aggregate material more than +/- ¾ in. over a 10 ft. long straightedge laid in any direction.

b. Do not exceed the specified surface grade of the compacted Permeable Base Aggregate material more than +/- ½ in. over a 10 ft. long straightedge laid in any direction.

5. Grade and compact the upper surface of the Permeable Base Aggregate material sufficiently to prevent infiltration of the Permeable Setting Bed Aggregate material both during construction and throughout its service life.

D. Permeable Setting Bed Aggregate

1. Provide, spread and screed Permeable Setting Bed aggregate evenly over the Permeable Base Aggregate course.
    a. Protect screeded Permeable Setting Bed Aggregate from being disturbed.
    b. Screed only the area which can be covered by pavers in one day.
    c. Do not use Permeable Setting Bed Aggregate to fill depressions in the base surface.
2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and lightly compacted.
3. Inspect the Permeable Setting Bed Aggregate course prior to commencing the placement of the permeable concrete pavers.

E. Permeable Pavers

1. Replace pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
2. Mix Permeable Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures.
3. Exercise care in handling face mix pavers to prevent surfaces from contacting backs or edges of other units.
4. Provide Permeable Pavers using joint pattern as indicated. Adjust joint pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
5. Use string lines or chalk lines on Permeable Setting Bed aggregate to hold all pattern lines true.
6. Set surface elevation of pavers 1/8 in. above adjacent drainage inlets, concrete collars or channels.
7. Place paver units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.

a. When installation is performed with mechanical equipment, use only pavers with spacer bars on sides of each unit.

8. Provide space between paver units of 1/32 in. wide to achieve straightbond lines.

9. Prevent joint (bond) lines from shifting more than +/- ½ in. over 50 ft. from string lines.

10. Fill gaps between units or at edges of the paved area that exceed 3/8 inch with pieces cut to fit from full-size pavers.

11. Cut pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut pavers to provide pattern indicated and to fit adjoining work neatly. Use full paver units without cutting where possible. Hammer cutting is not acceptable.

12. Prevent all traffic on installed pavers until Permeable Joint Aggregate has been vibrated into joints. Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and Permeable Joint Aggregate material.

13. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

    a. After edge pavers are installed and there is a completed surface.

    b. Compact installed concrete pavers to within 6 feet of the laying face before ending each day's work. Cover pavers that have not been compacted and leveling course on which pavers have not been placed, with non-staining plastic sheets to prevent Permeable Setting Bed Aggregate from becoming disturbed.

14. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.

15. Remove any cracked or structurally damaged pavers and replace with new units prior to installing Permeable Joint Opening Aggregate material.

16. Provide, spread and sweep Permeable Joint Opening Aggregate into joints immediately after vibrating pavers into Permeable Setting Bed course until full. Vibrate pavers and add Permeable Joint Aggregate material until joints are completely filled, then remove excess material. This will require at least 4 passes with a plate compactor.

17. Remove excess Permeable Joint Aggregate broom clean from surface when installation is complete.

3.03 FIELD TESTING / QUALITY CONTROL

A. Install permeable pavers only on unfrozen Permeable Setting Bed Aggregate materials.

B. Install permeable setting bed only on unfrozen Permeable Base and Subbase Aggregates.

C. Install Permeable Base or Subbase Aggregates only over unfrozen subgrade.

D. Verify final elevations for conformance to the drawings after sweeping the surface clean.

1. Prevent final Permeable Paver finished grade elevations from deviating more than +/- 3/8 in. under a 10 ft straightedge or indicated slope, for finished surface of paving.

E. Paver-to-Paver Lippage:

1. No greater than 1/8 inch difference in height between adjacent pavers.

2. Test by application of clean water at the rate of at least 5 gpm over the surface, using a hose or other distribution devise.

F. Maintenance and Cleaning Testing

1. After cleaning and no later than three (3) calendar days after cleaning, the Contractor must conduct percolation rate testing every 10,000 square feet of paver area in accordance with ASTM C1701. All testing must be done in coordination with and in the presence of the Engineer.

2. Testing locations will be chosen at the Engineer's discretion and in accordance with the ASTM requirements.

3. The Contractor shall provide testing results to the Engineer for review within seven (7) days after the completion of testing. Paver sections with infiltration rates below the minimum infiltration rate of 150 inches per hour must undergo corrective action (such as cleaning or replacement).

4. After corrective action has taken place, then one other unit in the same contiguous section will be randomly selected by the Engineer and tested to ensure that the section of paver area meets the specified infiltration rate. If the selected unit fails to meet that rate, then the section must be cleaned again, and the testing process repeated until passing results are obtained.

5. Cleaning will be deemed sufficient only if the minimum of 150 inch/hr infiltration rate has been met. The Engineer will conduct field inspections

to ensure the proper condition and performance of the permeable paver system. Visual inspections and infiltration tests will be used to determine the performance of the permeable pavers.

6. If the Engineer determines that the Contractor's performance of maintenance work is insufficient, the Contractor shall submit a revised method or maintenance schedule. The Contractor shall perform subsequent corrective maintenance work at no additional cost to the City.

G. Acceptance for Substantial Completion Testing

1. Prior to acceptance for Substantial Completion, the Contractor must conduct percolation rate testing every 10,000 square feet of paver area in accordance with ASTM C1701. All testing must be done in coordination with and in the presence of the Engineer.

2. Testing locations will be chosen at the Engineer's discretion and in accordance with the ASTM requirements.

3. The Contractor shall provide testing results to the Engineer for review within seven (7) days after the completion of testing. Paver sections with infiltration rates below the minimum infiltration rate of 150 inches per hour must undergo corrective action (such as cleaning or replacement) prior to issuance of Substantial Completion.

4. After corrective action has taken place, then one other unit in the same contiguous section will be randomly selected by the Engineer and tested to ensure that the section of paver area meets the specified infiltration rate. If the selected unit fails to meet that rate, then the section must be cleaned again, and the testing process repeated until passing results are obtained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjustments

1. Remove and replace defective, broken or damaged paver units or system components, including but not limited to the following defects:

a. Not matching approved samples

b. Broken, chipped, stained, or otherwise damaged

c. Defective setting beds

d. Unfilled or defective joints

e. Uneven settling, or other evidence of improper bedding or alignment

f. All other defects as directed by the Engineer

2. Permeable Joint Aggregate Material Refilling

a. Remove all debris from joint and provide additional Permeable Joint Aggregate material after 120 days and before 150 days after date of Substantial Completion. Fill Permeable Joint Aggregate material full to the lip of the paver.

B. Protection

1. Protect newly installed pavers with panels of plywood on which the installer stands.

a. Plywood can be advanced as work progresses. Plywood protection must be kept in areas which will be subjected to continued movement of materials and equipment.

b. Cover top of paving with non-staining waterproof sheeting at end of each day's work. Covers shall be securely held in place.

c. Cover partially completed paving when work is not in progress.

2. Prevent staining of pavers

a. Immediately remove such materials from pavers without damage to latter.

b. Protect bases of walls from rain-splashed mud and splatter by means of coverings spread on ground and over wall surface.

3. The Contractor shall maintain all paving for the duration of the guarantee period after Substantial Completion of the Work and shall repair and replace all Work that is disturbed, damaged, or destroyed without additional payment.

4. The Contractor must conduct periodic maintenance and cleaning, at minimum:

a. Towards the end of the spring pollen season (typically June-July)

b. Towards the end of the fall leaf falling season (typically December-mid January)

c. Just prior to the end of the guarantee period unless the pavers were last cleaned within 120 calendar days.

5. Maintenance of Permeable Joint Aggregate Material

a. Annually inspect Permeable Joint Aggregate material for areas clogged with debris.

b. Vacuum or sweep as necessary to restore surface infiltration.

c. Remove debris by vacuuming or sweeping Permeable Joint Aggregate

d. Replenish removed Permeable Joint Aggregate material with clean aggregate material flush to paver lip.

e. Sweep excess material from paver surface.

C. Clean-Up

1. Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean using mild non-corrosive materials and brushes. All surrounding paving materials or other structures shall be cleaned of all stains.

a. Clean Permeable Pavers in accordance with the manufacturer's written recommendations.

2. Testing After Cleaning

a. The Contractor must conduct percolation rate testing as described in Part 3.03.F.

3. After completion of the work, the Contractor shall remove all debris and excess materials, restore all damaged areas and leave the area in a clean state acceptable to the Engineer.

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 32 16 13 - CURBS AND GUTTERS
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, and equipment required to provide concrete curbs, headers, and sidewalks, as shown, specified and required.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 31 23 16 - Excavation

B. Section 31 23 23 - Fill

C. Section 03 10 00 - Concrete Forming and Accessories

D. Section 03 30 00 - Cast-in-Place Concrete

E. Section 03 35 00 - Concrete Finishing

F. Section 05 50 00 - Metal Fabrications

G. Section 09 91 00 - Painting

1.04 REFERENCES

A. New York State Department of Transportation (NYSDOT) Standard Specifications

B. New York State Department of Transportation (NYSDOT) Standard Sheets.

C. New York State Department of Transportation (NYSDOT) Highway Design Manual

1.05 DESCRIPTION

A. Design Requirements

1. Concrete curbs, headers, and sidewalks which are outside the building line of the Site and under jurisdiction of other agencies, even though constructed as part of this Contract, shall be constructed in accordance with the Rules and Regulations, Standard Details and Standard Specifications of the governing agency in effect at the time of the award of this Contract and as specified and defined in the Contract Drawings.

2. Unless otherwise specified and defined in the Contract Drawings, concrete for curbs, headers, and sidewalks which are inside the building line of the Site and not under the jurisdiction of other agencies shall meet the following requirements:

a. 3500 psi minimum 28-day compressive strength.

b. Utilize type II Cement and contain aggregate conforming to ASTM #57.

c. Water-cement ratio not exceeding 0.44 for normal weight structural concrete.

d. Slump values of 1-1/2 inch minimum to 4 inch maximum.

e. Desired air-entrainment of 6.5%, with an allowable range of +/- 1.5%.

f. Concrete shall be proportioned, mixed, placed, cured and protected in accordance with the requirements of Section 03 30 00 Cast-in-Place Concrete.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Those required in Section 03 30 00 - Cast-in-Place Concrete.
2. Marked-up drawings and shop drawings including shop and field test reports of concrete samples tested in an approved laboratory.
3. Concrete sidewalk and curb layouts showing scoring and joint layouts, including joint and sealant materials to be incorporated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Coarse aggregate, unless otherwise specified, shall conform to the requirements of Section 03 30 00 - Cast-in-Place Concrete.

B. Concrete shall be air-entrained in accordance with Section 03 30 00 - Cast-in-Place Concrete.

C. Material for foundation of curbs, headers, and sidewalks shall consist on Type 1 stone or gravel complying with the requirements of Section 733-04, NYSDOT Standard Specifications, 100 percent of which passes a 3-inch square sieve; or other approved broken concrete, 100 percent of which passes a 2-1/2-inch square sieve; or other approved granular material containing not more than 5 percent material passing a No. 200 mesh sieve and not more than 5 percent retained on a 2-inch square sieve.

D. Unless otherwise specified and defined in the Contract Drawings preformed expansion joint filler shall be 3/4-inch premolded resilient joint filler as described in Section 705-07 of the NYSDOT Standard Specifications.

E. Joint sealing compound for horizontal joints shall be Silicon sealer as described in Section 705-05 of the NYSDOT Standard Specifications.

F. Precast concrete wheel stops:

1. General: Precast concrete wheel stops shall be steel-reinforced, air entrained concrete with 4,000 psi minimum compressive strength.

2. Reinforcement: two #3 rebars. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or drilled vertical holes through wheel stop for anchoring to substrate.

3. Source Limitations: Obtain wheel stops from single source from single manufacturer.

4. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.

5. Surface Sealer: Manufacturer's standard salt-resistant, clear sealer, applied at precasting location. F.6. Mounting Hardware: Galvanized-steel dowel, 1/2-inch diameter, 30-inch minimum length.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Concrete shall be tested and evaluated for strength and acceptance in accordance with the requirements of Section 03 30 00 Cast-in-Place Concrete.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. Sidewalk Installation

1. Concrete sidewalk shall be of the width shown or otherwise specified and shall be laid on 6 inches thick compacted broken stone base, unless otherwise specified or shown on the Contract Drawings.

2. Sidewalk shall consist of a single course of concrete 4 inches thick, unless otherwise shown on the Contract Drawings.

3. Concrete shall be pigmented when specified and defined in the Contract Drawings.

4. Excavation and subgrade preparation shall be in accordance with the requirements of Section 31 23 16 - Excavation. All existing material within the required 6 inches of foundation shall be removed in its entirety. Additional depth of foundation material for special conditions shall be placed as required by the Engineer.

5. Materials: Foundation material shall be placed on the prepared subgrade and thoroughly compacted into a course not less than 6 inches thick. The top surface shall be parallel to the finished grade and at a distance below the grade equal to the specified thickness of concrete.

6. Forms: Forms shall be in accordance with Section 03 10 00 – Concrete Forming and Accessories.

7. Slabs: Concrete sidewalk shall be built in approximately 20-foot lengths between expansion joints. The sidewalk shall be separated from adjoining structures by expansion joints. When directed, these joints shall be filled with dry sand. Expansion joints in sidewalk shall coincide with expansion joints in curb. Tooled control joints not less than 1/2 inch in depth shall be provided where at four-foot intervals unless otherwise shown on the Contract Drawings.

8. Expansion Joints: Transverse expansion joints shall be 1/2 inch in width and shall be filled with preformed joint filler to within 1 inch of the sidewalk surface. The top 1 inch shall be sealed with silicon sealer - complying with the requirements of Section 705-05 of the NYSDOT Standard Specifications.

9. The foundation material shall be wetted immediately before concrete is placed. The concrete shall be placed within the forms and thoroughly tamped until the surface is at the finished grade.

10. When specified and defined in the Contract Drawings, the concrete sidewalk shall be pigmented with a minimum of 2 pounds of dispersed carbon black per bag of cement to produce a bluestone color. Either the coloring pigment shall be treated so as not to cause an increase or decrease of the entrained air content in cement mortar or in the concrete of more than 10 percent, or the amount of air-entrainment agent added to the concrete shall be adjusted to meet the specified requirements. All cement used for concrete work specified herein shall be of uniform color. Requirements for other colors are specified and defined in the Contract Drawings.

11. The top surfaces shall be finished in accordance with Section 03 35 00 – Concrete Finishing. Each rectangular slab shall have all edges neatly rounded with proper tools and be bounded on all sides by a troweled border about 1 inch in width. Surface texture of pedestrian ramps shall be transverse grooves, 1/2 inch wide by 1/4 inch deep on 2-inch centers.

12. Backfilling shall follow the removal of forms as soon as practicable and, unless otherwise permitted, shall be of clean earth, satisfactorily compacted. Backfilling shall conform to the requirements of Section 31 23 23 - Fill.

13. Concrete sidewalk shall be cured according to Section 03 30 00 Cast-in-Place Concrete.

B. Curb and Header Installation

1. Concrete curbs and headers, except as otherwise detailed and specified, shall be constructed in accordance with the applicable provisions of Sections 609 and 714-04 , NYSDOT Standard Specifications, except that concrete strength shall conform to Class 45 as indicated in Section 03 30 00

Cast-in-Place Concrete. Depressed curbs shall be provided where specified or shown on the Contract Drawings.

C. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes the requirements for metal fencing. Metal fencing shall be as specified herein and as shown on the Contract Drawings. The fence shall be all metal, constructed of wire fabric fastened to top, bottom and intermediate horizontal rails and to vertical line posts, corner posts and terminal posts and shall include all system components such as gates, fittings, fastenings and other accessories with polymer coating and other protective coatings as specified.

B. Unless otherwise shown or specified, all metal fencing shall be furnished and installed as specified. It is the intent that the Contract will include any variations necessary for specific applications.

C. The Contractor shall implement practices and procedures to meet the Project's sustainability goals as identified in the Contract Documents. The Contractor shall ensure that the sustainability requirements of this Section are implemented to the fullest extent.

D. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete

B. Section 05 05 13.01 - Galvanizing

1.04 REFERENCES

A. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, Standard Specification for

B. ASTM A90 - Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, Standard Test Method for

C. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, Standard Specification for

D. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, Standard Specification for

E. ASTM A817 - Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire, Standard Specification for

F. ASTM A824 - Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence, Standard Specification for

G. ASTM A1011 - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength, Standard Specification for

H. ASTM B6 - Zinc, Standard Specification for

I. ASTM F567 - Installation of Chain-Link Fence, Standard Practice for

J. ASTM F626 - Fence Fittings, Standard Specification for

K. ASTM F900 - Industrial and Commercial Swing Gates, Standard Specification for

L. ASTM F1043 - Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework, Standard Specification for

M. ASTM F1083 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures, Standard Specification for

N. ASTM F1184 - Industrial and Commercial Horizontal Slide Gates, Standard Specification for

O. CLF-PM0610 - Chain Link Fence Manufacturers Institute: Product Manual

P. New York State Department of Transportation Standard Specifications – Section 607.

Q. New York State Department of Transportation Standard Drawings – Section 607.

1.05 DESCRIPTION

A. Comply with the standards of the Chain Link Fence Manufacturers Institute for product and installation requirements and the requirements of ASTM F567. Comply with the NYSDOT Standard Specifications Section 607 and NYSDOT Standard Drawing 607-01, 607-04 and 607-06. These standards shall represent a minimum level of quality when additional information is not shown or specified in the Contract Documents.

B. The fabricator shall be responsible for providing structural calculations for the metal fence system to Contractor for submittal to Engineer as part of Shop Drawing review. Structural analysis shall verify that all system components including, but not limited to, supports, gates, fasteners, fittings and connections meet the requirements of the New York State Building Code.

C. Member sizes, thicknesses and weights shown or specified shall be considered minimum. Where structural analysis indicates the need for additional members or increased member size, thickness or weight, these shall be provided at no additional expense to the City.

D. Modifications may be made only as necessary to meet field conditions to ensure proper fitting and support of the Work and only upon submittal of Shop Drawing and receipt of approval by Engineer.

E. Sustainable Design Requirements

1. Recycled Content of Metal Fence: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:

1. Contractor shall select a single installer regularly engaged in the installation of metal fencing with successful experience in the erection of the type of metal fencing specified. Installer shall agree to employ only tradesmen with specific skill and experience in the erection of this type of work.

2. Contractor shall submit the name and experience record of the installer to Engineer along with the names and telephone numbers of owners, architects or engineers responsible for the Project and the approximate contract cost of the metal fencing and the amount of area installed.

3. Contractor shall submit evidence of approval of the installer by the metal fence manufacturer. Installers who have not had the type of experience required to perform the kinds of work required will not be approved.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittal shall include, but not be limited to:

1. Each component, fastener, post, rail, support, chain link fabric and other items labeled as to the use and location in the work.

2. Samples approximately 6 inches long, and 6 inches square of all chain link fence fabric materials including framework members, and typical accessories. Engineer's review will be for workmanship only. Compliance with all other requirements is the responsibility of Contractor.

B. Shop Drawings: Submit for approval the following:

1. Copies of manufacturer's technical product information, specifications and certified test reports on physical properties, and installation instructions for all metal fencing system components.

2. All structural calculations verifying that all system components comply with the requirements of the New York State Building Code.

3. Large-scale details drawn at a scale of 3 inches to the foot for all connections and gate details. Drawings at a scale of 1/4 inch equals 1 foot of typical metal fence assembly identifying all components, metal fence heights, locations, and sizes and weights of all rails, posts, braces, supports and footings.

4. A list of all hardware and accessories.

C. Sample Mock-Ups

1. Materials for the Work and full size sample mock-up shall be as shown on the Contract Drawings and as specified herein.

2. The Contractor shall build a full size sample mock-up at the Project Site to demonstrate the ability to match the quality of workmanship, methods of detailing, and tolerances shown on the Contract Drawings and as specified herein. Once approved, the sample mock-up shall serve as a standard for all metal fence installation work required under the Contract.

3. Full size sample mock-ups that, in the opinion of Engineer, do not adequately demonstrate the ability of the installer to provide the requirements specified will not be approved and Contractor shall proceed to propose an alternative installer to Engineer for approval.

4. Cost of all full size sample mock-ups shall be at the expense of Contractor.

5. Each fabricator and installer proposed by Contractor shall be permitted to build two full size sample mock-ups using approved components as

required to obtain Engineer's approval. If after building two mock-ups, Engineer is still uncertain that the fabricator or installer is capable of matching the workmanship, methods of detailing and performance requirements specified, Contractor shall propose alternative fabricators and installers. Contractor will be required to continue this process until the work of an acceptable fabricator and installer is approved.

6. Full size sample mock-up shall not be altered, moved or destroyed until written permission is received from Engineer. Mock-ups destroyed before Contractor receives written permission shall be rebuilt at no additional expense to the City.

D. Sustainable Design Submittals:

1. Environmental Materials Reporting Form (EMRF) Recycled Content. Provide the following information:

a. Name of Product and Manufacturer.

b. Material cost breakdowns. Cost breakdowns must include total material-only cost (excluding installation, labor and equipment).

c. The percentage (by weight) of post-consumer and pre-consumer recycled content for the submitted product.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:

1. Deliver materials in manufacturer's original, unopened packaging with all tags, labels and other identifying information intact and legible.

B. Storage of Materials:

1. Store all materials under weatherproof cover, off the ground and away from other construction activities. Do not store material in a manner which would create a humidity chamber. Provide for free movement of air under protective cover and between components of the metal fence system.

C. Handling of Materials:

1. Handle material in a manner that is in compliance with product institute standards and that will prevent damaging coatings.Spare Parts, Special Tools, and Supplies

1.09 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. General:

1. All parts of the metal fence system shall be galvanized steel, except that chain link fence fabric shall be aluminum-coated steel and fittings may be galvanized malleable iron, or galvanized wrought iron.
2. Wire gauges shall conform to American Steel and Wire Company gauge.
3. Concrete for footings shall be Class 25 conforming to the requirements of Section 03 30 00 – Cast-in-Place Concrete.
4. Pipe sizes shall be commercial pipe sizes complying with ASTM F1083.
5. Tube sizes specified are nominal outside dimensions.
6. Roll-formed section sizes are the nominal outside dimensions.
7. Heat-form all arcs and chords before protective coatings are applied to metal.
8. All sizes specified are given for uncoated steel. All protective coatings are in addition to specified dimensions and sizes.
9. All galvanizing shall be done in accordance with Section 05 05 13.01 - Galvanizing.

B. Chain Link Fence Fabric:

1. Fabric shall be in one-piece widths for fencing 12 feet - 0 inches and less in height to comply with Chain Link Fence Manufacturers Institute, Product Manual.
2. Wire mesh shall be woven throughout in the form of a uniform square mesh with parallel sides and horizontal and vertical diagonals of uniform dimension. Wire mesh shall be 1” spacing. Wire shall be 9 gauge. Wire material shall be ASTM A817, Type 1, cold-drawn carbon steel wire with minimum breaking strength of 2,170 pounds and coated with 0.40 ounces of aluminum by the hot-dip process per square foot of wire surface. The fabric shall be recommended by the Chain Link Fence Manufacturers Institute for heavy industrial usage.
3. Provide fabric knuckled on edges to prevent unraveling.

C. Framework:

1. General: The following table is provided for the convenience of Contractor and provides actual OD and equivalent nominal NPS size and trade size of round members. Pipe shall be commercial grade, plain end steel pipe with standard weight walls. Steel strip used in the manufacture of pipe shall be in compliance with ASTM F1083, Schedule 40 pipe with minimum yield strength of 25,000 psi and with 1.8 ounces of hot-dipped zinc coating per

square foot of surface area. Type A coating shall be applied both inside and outside according to ASTM F1043, as determined by ASTM A90.

Actual OD	NPS Size	Trade Size
1.315	1	1-3/8
1.660	1-1/4	1-5/8
1.900	1-1/2	2
2.375	2	2-1/2
2.875	2-1/2	3
3.500	3	3-1/2
4.000	3-1/2	4
6.625	6	6-5/8
8.625	8	8-5/8

2. For maximum metal fence system height of 8 feet - 0 inches provide posts, gate frames and rails shall be of the following nominal pipe sizes and minimum weights per linear foot:
   a. Line Posts: 2-1/2 NPS @ 5.79 lbs. per foot
   b. End, Corner and Pull Posts: 3 NPS @ 7.58 lbs. per foot
   c. Gate Frames: 2 NPS @ 3.65 lbs. per foot
   d. Gate Posts:
      1) For single gates 6 ft. wide or less, or double gates 12 ft. wide or less: 3 NPS @7.58 lbs. per foot.
      2) For single gates more than 6 ft. wide, or double gates more than 12 ft. wide: 4 NPS @ 10.79 lbs. per foot.
   e. Top Rails, Intermediate Rails, Bottom Rails and Braces: 1-1/2 NPS @ 2.72 lbs. per foot.
3. Provide manufacturer's longest length rails, with extra-long expansion sleeves making firm connections but permitting expansion and contraction for each joint. Provide means for attaching the top rail securely to each gate, corner, pull and terminal post.

D. Roll-Formed Steel: Rolled steel shapes shall be produced from structural-quality steel conforming to ASTM A1011, Grade 45, or ASTM A446, Grade D, galvanized, with a minimum yield strength of 45,000 psi. Protective coating system shall conform to ASTM F1043, Type A, hot-dipped galvanizing with a minimum

of 4.0 ounces of zinc per square foot of surface area in accordance with the requirements of ASTM A653.

E. Fittings and Accessories: All fittings and accessories shall comply with ASTM F626.

1. Post Caps: Pressed steel, cast iron or cast aluminum alloy, fitting snugly over posts to exclude moisture; cone-type caps for terminal posts and loop-type caps for line posts.
2. Rail and Brace Ends: Pressed steel, cast iron or cast aluminum alloy, cup-shaped to receive rail and brace ends.
3. Rail Sleeves: Tubular steel, 0.051-inches thick by 7-inches long, expansion type.
4. Tension Bars: Steel strip, 5/8-inch wide by 3/16-inches thick.
5. Tension Wire: Marcelled 7 gauge steel wire with minimum coating of 0.40 ounces per square foot of wire surface in compliance with ASTM A824.
6. Tension Bands: Pressed steel, 12 gauge thick by 3/4-inch wide.
7. Truss Rods: Steel rod, 3/8-inch diameter merchant quality with turnbuckle.
8. Fence Latches:
    a. Manufacturer's double latching bar latch devices with heavy mil polyvinyl chloride coating.
    b. Padlock eye as integral part of latch.
9. Keeper: Provide a gatekeeper for vehicle gates that automatically engages gate leaf and holds it in the open position until manually released.
10. Gate Hinges: 180 degree offset heavy-industrial hinges; 1-1/2 pair per leaf.
11. Tie Wire: Aluminum; 9 gauge, alloy 1100-H4; polyvinyl chloride coated to match fence fabric.
12. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage a center drop rod or plunger bar. A locking device and padlock eyes shall be included as integral parts of the latch, permitting both gate leaves to be locked with a single padlock.

F. Gates:

1. Swing gates shall comply with ASTM F900.
2. Sliding gates shall comply with ASTM F1184.

G. Hog Rings: Steel wire, 11 gauge, with a minimum zinc coating of 0.80 ounces per square foot of wire surface.

H. Galvanizing: Zinc for galvanizing shall be of High Grade or Special High Grade conforming to ASTM B6 with a maximum aluminum content of 0.01 percent. Material shall be galvanized by the "hot-dip" process in conformity with the following standards:

Class of Work	ASTM
Structural Iron and Steel Shapes	A123
Fittings and Accessories	F626
Pipe	A53

I. Precast Concrete Median Barrier (Jersey Barrier): The Contractor shall furnish and install precast concrete barriers as necessary or required by the Engineer. All materials shall be in accordance with NYSDOT Standard Specification §704-05 Precast Concrete Barrier and Standard Sheet 619-001.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Fabrication Tolerances:

1. Fabric, posts, rails, and other supports shall be straight or uniformly curved to provide the profiles shown on the Contract Drawings, to a dimensional tolerance of 1/16 inch in 10 feet - 0 inches without warp or rack in the finished installation.

B. Fabrication shall comply with ASTM F1083 for metal fencing, ASTM F1184 for horizontal slide gates, and ASTM F900 for swing gates.

C. In addition to specified standards, fabrication shall comply with Chain Link Fence Manufacturer's Institute Standard, **CLF-PM0610** - Product Manual.

D. Gates:

1. Gate hinges shall be of the double clamping offset type. To hold the gate in the open or closed positions, each gate frame shall be provided with a keeper which automatically engages a gate shoe set in concrete. Gates shall have a drop latch with provision for a padlock. Each gate shall be provided with a heavy-duty bronze padlock and shackle chain, No. 160DHM with 11/32-inch marine brass shackle as manufactured by:

   a. The Master Lock Company, Oak Creek, WI.

   b. Or approved equal.

   And three keys for each padlock. Where more than one gate is required for the same enclosure, padlocks shall be keyed the same.

2. All gate frames shall have intermediate horizontal rails. Gate frames shall be of welded construction and shall be galvanized after fabrication. Single gates 6 feet wide or wider and double gates 12 feet wide or wider shall be provided with diagonal bracing in one direction, extending from top to

bottom rail. The diagonal bracing shall be at least 1/2 inch in diameter and shall be provided with turnbuckles.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

1. Source Quality Control

   a. Provide metal fencing system as a complete system with all gates, hardware, appurtenances and other components produced by a single manufacturer, including custom erection accessories, fittings, clamps and fastenings as may be necessary or required.

   b. Provide fence fabric imprinted with the manufacturer's trade name, country of origin, core wire gauge, and finished outside diameter gauge. Material delivered to the Project Site lacking this information will be rejected for use in the Work and shall be immediately removed even if discovered after being incorporated in the Work, at no additional expense to the City.

   c. Provide shipping list for materials used, endorsed with the manufacturer's voucher certifying that the material used in the metal fencing system complies with these Specifications.

   d. Structural shapes of satisfactory sections and equal strengths may be substituted if approved by Engineer.

2. Shop Tests

   a. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Preparation

1. Field Measurements: Take field measurements and verify layout information and dimensions for metal fencing and gates in relation to property surveys and existing conditions.

2. Do not begin installation and erection of the metal fencing system until final grading is completed.

3.02 INSTALLATION

A. General:

1. Install metal fencing system in compliance with ASTM F567.

2. Apply fabric to outside of framework. Install fencing on boundary lines inside of property line established by survey.

3. Do not begin metal fence installation and erection before the final grading has been completed, and finish elevations have been established.

B. Excavation:

1. Drill or hand-excavate (using post-hole digger) holes for posts to diameters and spacing's shown or specified, in firm, undisturbed or compacted soil.
2. Unless otherwise indicated, excavate hole depths approximately 6 inches lower than post bottom.
3. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the Project Site, as directed.
4. When solid rock is encountered near the surface, drill into rock at least 12 inches for line posts and at least 18 inches for end, pull, corner and gate posts. Drill hole at least 1 inch greater in diameter than the largest dimension of the post to be placed. Remove rock cores from the Site.
5. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed the minimum depths specified above.

C. Setting Posts:

1. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
2. Center and align posts in a continuous pour, and vibrate or tamp concrete for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
3. Posts shall be set in concrete footings, except as otherwise shown or specified. Line posts shall extend at least 3 feet below finished grade, and gate posts shall extend at least four feet below finished grade. Concrete footings shall have a minimum diameter of 15 inches and shall extend at least 6 inches below the bottom of the posts. Tops of concrete footings shall receive a troweled finish. Top of footing shall be 2 inches above finish grade and sloped to direct water away from posts. The portion of posts embedded in concrete shall receive two coats of an approved coal tar paint before embedment.
4. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing materials, or other acceptable curing method.
5. Grout posts when installed in sleeved holes, concrete constructions, and rock.
6. Allow concrete to attain at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than seven days after placement, before rails, tension wire, or fabric is installed. Do not stretch and tension fabric or wires, and do not hang gates until the concrete has attained its full design strength.

D. Chain Link Fence Fabric:

1. Pull fabric taut so that fabric remains in tension after force is released, with bottom edge 1 inch above grade. Fasten to terminal posts and gate posts with tension bars threaded through mesh and secured with tension bands at maximum intervals of 14 inches. Tie to line posts, gate frames and top and bottom rails with tie wires spaced at maximum 12 inches on posts and 24 inches on rails.

2. The tension bars shall be connected to posts and frames by means of adjustable bolts and bands spaced not more than 14 inches apart.

E. Top Rails, Intermediate Center Rails and Bracing:

1. Install top rails through line post caps, bending to radius for curved runs, connecting sections with sleeves to form a continuous rail between terminal posts.

2. Install center rails only where shown or specified. Install center and bottom rails in one piece between posts and flush with the post on the fabric side, using rail ends and special offset fittings where necessary.

3. Install brace assemblies at end posts and at both sides of corner and pull post panels. Panels adjacent to gates shall have intermediate horizontal rails and diagonal bracing. The diagonal bracing shall run from the center of the first line post to the bottom of the terminal post.

F. Tie Wire: Use U-shaped wires conforming to diameter of pipe. Wire shall clasp pipe and fabric firmly, and each end of the wire shall be wrapped around the fabric at least two full turns and bent to minimize hazard to persons or clothing.

G. Fasteners:

1. Install nuts for fittings, bands and hardware bolts on side of metal fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting

1. Gates: After repeated operation of completed installation equivalent to three days of use by normal traffic, readjust gates for optimum operation and safety.

2. Lubricate operating equipment and clean exposed surfaces.

B. Protection

1. Repair and replace all broken or bent components. Repair coatings damaged in the shop or during field erection by recoating with manufacturer's recommended repair compound, applied in accordance with manufacturer's directions.

2. Protect metal fencing system from construction traffic and all other damage until acceptance of the work.

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. Planting as specified herein includes, but is not limited to, the following:

1. Furnishing and installing new trees, shrubs, grasses, and all other plant materials.
2. Furnishing and installing new seeded, hydro-seeded, and sodded areas.
3. Staking and guying of trees, only where shown on the Contract Drawings or as directed.
4. Furnishing and installing filter fabric and drainage gravel under planted areas, in areas as shown on the Contract Drawings.
5. Furnishing and installing mulch.
6. Protection and maintenance of all plant materials and the replacement of plantings as required until Substantial Completion.
7. Plant protection, maintenance and replacements during guarantee period.

B. The Contractor shall implement practices and procedures to meet the Project's sustainability goals as identified in the Contract Documents. The Contractor shall ensure that the sustainability requirements of this Section are implemented to the fullest extent.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 31 23 23 - Fill

B. Section 31 25 10 - Dust, Soil Erosion and Sediment Control

C. Section 32 90 05 - Soil Mixes

1.04 REFERENCES

A. AmericanHort

1. American Standard for Nursery Stock (ASNS), ANSI Z60.1, current edition

B. New York Flora Atlas (http://newyork.plantatlas.usf.edu/Default.aspx)

C. USDA Plant Database (http://plants.usda.gov/java/) & USDA Plant Hardiness Zone Map (http://planthardiness.ars.usda.gov/PHZMWeb/)

D. New York State Stormwater Management Design Manual (latest version)

1.05 DESCRIPTION

A. Contractor shall locate all required plant materials and be present for their inspection, as directed by the Engineer, at the nursery prior to transport or upon delivery of the materials on Site. Notify the Engineer at least 14 days in advance of the Contractor's desired inspection dates and locations. The Engineer may designate a DEP Bureau of Water Supply Restoration Specialist as the Engineer's representative.

B. Inspection at Nursery: All plants may be inspected and selected by the Engineer at the nursery for conformity to the requirements of the Contract. Whether plant materials are inspected or not at the nursery, the Contractor shall make all preselection arrangements required by the Engineer to ensure an efficient selection procedure. Approval of plant materials at the nursery shall not affect the rights to inspect or reject the materials upon delivery or later.

C. Inspection at Delivery On-Site: Notify the Engineer at least five (5) working days in advance of delivery of plants to the Site.

1. The Engineer will inspect all plants upon delivery to the Site.

2. Contractor shall schedule a time for on-site inspection prior to planting, and shall arrange for adequate labor and equipment on-site at the time of inspection to unload, open, and handle plants during inspection.

3. The Engineer may reject any plant material prior to or upon delivery to the Site.

a. All plant material that is dead, dying or appears unhealthy will be rejected.

b. All plant material that has been improperly maintained, dug, transported or handled in such a way as to impair its appearance or health will be rejected.

c. All substitutions are subject to approval by the City.

D. The Engineer will be the sole judge of the condition of the plants.

1. All material that is rejected on Site shall be removed immediately from the Site, and replaced with new material selected or approved by the Engineer, at no additional cost to the City.

E. Sustainable Design Requirements:

1. Regional Materials: Provide plant materials that were grown and harvested, or extracted, within 250 miles of the Site unless otherwise required in the Contract.

1.06 QUALITY ASSURANCE

A. Comply with all rules, regulations, Laws and ordinances of local, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary for Work to comply with such requirements at no additional cost to City.

B. Procure and pay for permits and licenses required for Work of this Section. Obtain all required permits in a timely manner to avoid delays to the Work.

C. Plant Quality

1. Provide plant material to meet or exceed applicable standards defined by American Standard for Nursery Stock (ANSI Z60.1, latest edition). including plant names, size and grading standards.

a. Plants shall be typical of their species or variety with normal habits of growth, in accordance with ANSI Z60.1; sound, healthy and vigorous, well-branched and densely

foliated when in leaf, with healthy well developed root systems; and free from disease, abrasions of the bark, insect pests, eggs or larvae.

b. Plant species native to the Eastern United States shall be provided. Non-native species shall not be considered as substitutes for native species.

c. Plants shall be true to species and, if as a variety or cultivar, said cultivar or variety shall be listed in The New York Flora Atlas (http://newyork.plantatlas.usf.edu/Default.aspx) to determine nativity.

d. Native plant material shall be derived from the local genotypes of the native plants specified to the greatest extent practicable. No plant material shall be collected or harvested from non-nursery areas.

e. Plants that have escaped cultivation, or have accidentally been introduced or naturalized into native habitats, shall not be considered native to the Eastern United States. Refer to USDA Plants Database (http://plants.usda.gov/java) for taxonomy and New York Flora Atlas to determine nativity.

1.07 SUBMITTALS

A. Submit a Statement of Qualifications for the landscape Subcontractor. Qualifications shall show experience in the installation of landscape work of a similar type and scale to this Project within the last five (5) years.

B. Statement of Qualifications for the landscape Subcontractor shall consist of the following information:

1. Company name and address
2. Number of years in business under this name
3. Number of current full-time, part-time, and seasonal employees
4. Estimated number of employees intended for this Project
5. Current workload:
   a. Name and address of current projects
   b. Types and dollar amounts of work for which landscape Subcontractor is responsible in each current project
   c. Estimated completion date for each current project
6. References for three (3) projects completed within the last five (5) years, which are similar in scope to this Project, including the following information for each project:
   a. Name and address of project

b. General description of work

c. Dollar amount of landscape work performed

d. Dates landscape work was started and completed

e. Verified contact information for at least one (1) representative of the owner or prime construction contractors in each project:

1) Name,

2) Mailing address,

3) E-mail address, and

4) Telephone numbers (Office and Direct).

1. Contact information similar to above for at least one (1) representative of the Architect, Engineer, Landscape Architect, or other representative of the designer or construction manager for each project given as reference.

B. Samples: Submit samples of the following items:

1. Mulch: One (1) pound bag with manufacturer's certification of content

C. Growers/Nurseries: Contractor shall submit a list of proposed growers/nurseries prior to the commencement of any landscaping Work, with sufficient advance notice of at least 60 days or as stated in the Contract.

D. For nurseries, a copy of state inspection certificate for current year must be submitted.

E. Materials/Certificates: Contractor shall submit a list of all materials and certificates specified in this Section prior to the commencement of any landscaping Work, with sufficient advance notice of at least 30 days or as stated in the Contract.

F. All necessary state, federal and other inspection certificates as may be required by Law.

G. Planting Schedule: The Contractor shall submit its proposed planting schedule at least 180 calendar days prior to the commencement of any landscaping work, indicating dates for each type of landscaping work during normal seasons. Once the schedule has been accepted by the Engineer, dates shall only be revised as approved in writing by the Engineer and after the reasons for delay have been documented.

H. Product Data - Where applicable, the following product data shall be submitted:

1. Manufacturers' product information for filter fabric, showing conformance with the specified requirements.

2. Analysis of each seed or hydroseed mix to be used, showing percentage of each species, percentage of purity, weed content and germination of seed.

3. Identification of sod source and certification that all sod material is true to name, type, purity and other criteria in conformance with these specifications.

4. Certified analysis for each treatment, amendment, and fertilizer material specified and as used, including weight for packaged material.

5. Manufacturers' product information for erosion control blankets or mats, including documentation that products are 100% biodegradable.

I. Documentation: The Contractor shall submit written documentation at least 30 days prior to scheduled start of planting that all plant material has been ordered.

J. Maintenance Program: Submit written schedule of maintenance operations proposed for the guarantee period. Schedule shall be in the form of a list of all proposed maintenance tasks, with dates showing when each maintenance task will be performed and its frequency of occurrence.

K. Sustainable Design Submittals:

1. Environmental Materials Reporting Form (EMRF) Regional Materials. Provide the following information:

a. Name of Product and Manufacturer.

b. Material cost breakdowns. Cost breakdowns must include total material-only cost (excluding installation, labor and equipment).

L. Indicate the location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. For assemblies, include the percentage by weight that is considered regional.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials in unopened bags or containers, each clearly bearing the name of the producer, the material composition, manufacturers' certified analysis, and the weight of the material.

B. Handle all plant material to prevent injury to trunks, branches and roots.

1. Do not bend or bind-tie trees in such manner as to damage bark, break branches or destroy natural shape.

2. Do not drop or thrown plant material during delivery. Unloading shall be performed with appropriate equipment.

C. Pack and ship all plant material to ensure arrival at Site in good condition. Provide protective covering during transport and delivery.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All new plant material shall be maintained and guaranteed for a period of 1 year after the date of Substantial Completion.

B. Operations: The Contractor shall, for the duration of the guarantee period, cultivate, weed, prune, and water all trees, shrubs, herbaceous material, ground covers, meadows under this Contract to the satisfaction of the DEP Forester/Ecologist. The Contractor shall replace, according to the Contract Specifications any plant material that is dead or in a dying condition at the request of the DEP Forester/Ecologist. The DEP Forester/Ecologist shall be the sole judge as to the condition of the plants.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable suppliers of planting materials shall be as indicated below.

1. Hardscrabble Farms Nursery, North Salem, NY (www.hardscrabblefarms.com);
2. Pinelands Nursery, Columbus, NJ (www.pinelandsnursery.com);
3. New England Wetland Plants, Inc., Amherst, MA (www.newp.com);
4. One Nature Nursery, Bloomingburg, NY (www.onenaturellc.com);
5. Ernst Conservation Seed, Meadville, PA (www.ernstseed.com);
6. Sylva Native Nursery & Seed Company, Glen Rock, PA (www.sylvanative.com);
7. Octoraro Native Plant Nursery, Kirkwood, PA (www.octoraro.com);
8. Northcreek Nurseries, Oxford, PA (http://www.northcreeknurseries.com);
9. Or approved equal.

B. All nurseries supplying plant material shall have a registration certificate from the Department of Agriculture and Markets, Division of Plant Industry, New York (or similar organization in the state from which plant material is obtained) certifying that the plant material is apparently free of injurious insects, diseases and invasive plant material.

2.02 MATERIALS / EQUIPMENT

A. Trees and Shrubs

1. All woody plant material shall be nursery grown in accordance with good horticultural practice, for at least two (2) years under climatic conditions and soils similar to those at the Site. All plants shall be of specimen quality. All trees are to be uniform and matched. All trees shall have straight trunks with leader intact, undamaged and uncut. Trees with damaged or crooked leaders, bark or abrasions, sunscald, disfiguring knots, or insect damage will not be accepted.

2. All trees shall be freshly dug for this Project. Depth of planting shall be checked on all trees being tagged at the nursery. Remove all soil or other fill material above the natural point where the tree trunk begins to spread, (the flare), prior to digging and ball and burlap operations.

3. Size:

   a. Caliper measurement shall be taken on the trunk at 6 inches above the natural ground line for trees up to and including 4 inches in caliper, and 12 inches above the ground for trees greater than 4 inches in caliper.

   b. Height and spread dimensions refer to the main body of plant, and not from branch tip to tip.

   c. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified.

   d. Plants that meet measurements but do not possess a normal balance between height and spread shall be rejected.

   e. Plants larger than specified may be used only if approved by Engineer. Use of such plants shall not increase the Contract price. If larger plants are approved, the root ball shall be increased in proportion to the size of the plant. The Contractor shall verify that the size of the root ball will fit in prepared planting pits.

4. All trees shall be either container-grown or balled and burlapped stock (B&B), with a compact natural ball of earth, firmly wrapped and tied in burlap fabric, as appropriate for the size of the plant material.

   a. Root ball sizes shall be in accordance with standards specified in ASNI Z60.1

b. Plants with cracked or broken rootballs will not be accepted.

c. Only natural burlap fabric shall be acceptable for balling. Plastic and other non-biodegradable fabrics will not be accepted.

5. Staking and Guying Materials

a. Stakes (where specified only): 3-inch diameter cedar, fir, or hemlock stakes, with pointed ends. Stakes shall be straight, sound, and free from defects that may impair strength.

b. Tree tie: ¾-inch thick polypropylene woven tree tie

B. Drainage Gravel

1. Drainage fill shall conform to the requirements of Section 31 23 23 –Fill, and shall be clean, free from silt and organic materials.

C. Mulch

1. Mulch shall be a double-shredded natural forest product of a uniform grade, partially decomposed, undyed, free from sawdust, with no additives or any other treatment. Size of bark shall be from 5/8 inch to one and 1/4 inch.

2. Mulch sources shall be free of weed seeds, diseases or pest infestations including but not limited to the Emerald Ash Borer, Asian Longhorned Beetle and Spotted Lanternfly. Use of material from any areas that have been designated for quarantine of wood products by any state or federal Agency is strictly prohibited.

D. Sod Grass

1. All sod shall be vigorously growing, thick, uniform, fully established, and well-developed turf grasses from an approved single source sod farm, New York State Certified.

2. All sod shall conform to the following seed types and proportions:

a. 30% - One or two of the following Bluegrasses: Victa, Blacksberg, Preakness, Rugby, Dragon, Challenger or Unique

b. 35% - One or two of the following shade-tolerant Bluegrasses: Able, Eclipse, Nu-star, Warrens A-34, Bristol, Touchdown, or P-105

c. 30% - One of the following fine fescues: Aurora, Shadow or Discovery

3. Quality

a. All sod shall be certified free of disease, insect pests, eggs, larvae, fungi, and blight, as required by regulatory authorities.

b. All sod shall be free from noxious weeds, annual grasses, moss, large stones, tree roots, or other materials harmful to growth or that will interfere with future mowing or other maintenance of the sodded areas.

c. Sod sections shall be strong enough to support their own weight when held vertically with a firm grasp on upper 10 percent of pad.

d. All sod sections shall be uniformly moist and not excessively dry or wet.

e. Broken pieces and torn or uneven ends shall not be accepted.

4. Size

a. All sod shall be machine cut strips, in supplier's standard widths and lengths, but not less than 12 inches wide.

b. Thickness of pad shall be uniformly 3/4-inch ("1/4"), excluding top growth and thatch.

c. Each sod piece shall be cut to a uniform size with square corners.

5. Sod shall be freshly harvested, delivered, and installed within a period of 24 hours. Sod not installed within this time period shall be separately approved by the Engineer and shall be subject to conditions of material rejection.

E. Grass Seed for Lawn Areas

1. Grass seed for lawn areas shall be fresh re-cleaned seed of the latest crop. Unless otherwise specified in the Plans or Contract, seed mixture shall have the following proportions by weight:

a. 60% Kentucky Blue-grass

b. 20% Fine Fescue

c. 20% Perennial Ryegrass

2. All seed shall be delivered in standard size bags of the vendor, showing weight, purity, and percentage of seed varieties.

3. Grass seed for lawn areas shall be provided only for areas where lawn is specified. It shall not be furnished for temporary stabilization prior to final Site restoration in restoration projects.

F. Grass Seed for Hydroseeded Areas

1. Grass seed mix for hydro-seeding shall be fresh re-cleaned seed of the latest crop. Seed mixture shall have the following proportions by weight:
   a. 40% Creeping Red Fescue
   b. 30% Perennial Ryegrass
   c. 20% Annual Ryegrass
   d. 10% Kentucky bluegrass
2. All seed shall be delivered in standard size bags of the vendor, showing weight, purity, and percentage of seed varieties.
3. Grass seed for hydro-seeding shall be provided only for areas where hydro-seeded turf-grass is specified. It shall not be furnished for temporary stabilization prior to final Site restoration in restoration projects.

G. Meadow Areas Mix

1. Seed for meadow seeded areas shall be fresh recleaned seed of the latest crop.
2. All seed shall be delivered in standard size bags of the vendor, showing weight, purity, and percentage of seed varieties.
3. Seed shall be New England Conservation/Wildlife Mix from New England Wetland Plants, or equal.
4. Minimum percentages, by weight, of pure live seed and germination rates and maximum allowable percentages of weed seed specified shall be as established by application of tolerances provided under the Federal Seed Act or as otherwise specified herein. These requirements shall apply whether seed is used individually or mixed. Seed shall be no less than 70 percent Pure Live Seed (PLS) Seed failing to meet minimum requirements will be rejected.

H. Erosion Control Areas Mix

1. Seed for erosion control areas shall be fresh recleaned seed of the latest crop.
2. All seed shall be delivered in standard size bags of the vendor, showing weight, purity, and percentage of seed varieties.
3. Seed shall be New England Erosion Control/Restoration Mix for Dry Sites from New England Wetland Plants, or equal.
4. Minimum percentages, by weight, of pure live seed and germination rates and maximum allowable percentages of weed seed specified shall be as established by application of tolerances

provided under the Federal Seed Act or as otherwise specified herein. These requirements shall apply whether seed is used individually or mixed. Seed shall be no less than 70 percent Pure Live Seed (PLS) Seed failing to meet minimum requirements will be rejected.

I. Retention and Pond Areas Mix

1. Seed for bioretention and pond areas shall be fresh recleaned seed of the latest crop.
2. All seed shall be delivered in standard size bags of the vendor, showing weight, purity, and percentage of seed varieties.
3. Seed shall be New England Wetmix (Wetland Seed Mix) from New England Wetland Plants, or equal.
4. Minimum percentages, by weight, of pure live seed and germination rates and maximum allowable percentages of weed seed specified shall be as established by application of tolerances provided under the Federal Seed Act or as otherwise specified herein. These requirements shall apply whether seed is used individually or mixed. Seed shall be no less than 70 percent Pure Live Seed (PLS) Seed failing to meet minimum requirements will be rejected.

J. Underplanting Mix

1. All planted areas shall be underplanted with Underplanting Seed Mix
2. Seed shall be fresh re-cleaned seed of the latest crop. Unless otherwise specified in the Plans or Contract, seed mixture shall have the following proportions by weight:
   a. 30% Secale cereale
   b. 30% Lolium multiflorum
   c. 40% Avena sativa
3. All seed shall be delivered in standard size bags of the vendor, showing weight, purity, and percentage of seed varieties.
4. Minimum percentages, by weight, of pure live seed and germination rates and maximum allowable percentages of weed seed specified shall be as established by application of tolerances provided under the Federal Seed Act or as otherwise specified herein. These requirements shall apply whether seed is used individually or mixed. Seed shall be no less than 70 percent Pure Live Seed (PLS) Seed failing to meet minimum requirements will be rejected.

K. Grass Seed or Sod for Vegetated Swales

1. Seed or Sod for vegetated swales shall be in accordance with NYS Stormwater Management Design Manual - Table 5.9 – Mixture type A.

L. Filter Fabric

1. Filter fabric shall be non-woven type conforming to the requirements of Section 31 25 10 - Dust, Soil Erosion and Sediment Control.

M. Water

1. The Contractor shall be supply all required water to the Site at no additional cost to the City. In projects outside New York City, the Engineer will coordinate with the Contractor to locate a source of water.

a. The Contractor shall correct all Work injured or damaged because of the lack of water, or the use of too much water, or the use of contaminated water.

b. Water shall be free from impurities injurious to vegetation.

N. Tree Irrigation Bags

1. Unless otherwise shown on the Contract Drawings, required in the Contract, or directed by the Engineer, the Contractor shall furnish tree irrigation bags for all trees over 1-1/2 inch caliper. The irrigation bags shall be 100% reinforced UV stable polyethylene, at least 10 mils. thick with a polyester scrim lining, such as Tree-Gator, as manufactured by Spectrum Products, Raleigh, NC, or approved equal. The irrigation bags shall have a minimum 20-gallon capacity.

O. Erosion Control Mats

1. Erosion control blankets or mats shall be 100% biodegradable and free of any plastic.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examination

1. The Contractor shall coordinate its Work with that of Other Contractors. Such coordination shall include, but not be limited to:
   a. Location of all underground utility lines and structures
   b. Scheduling of planting operations
   c. Scheduling of maintenance operations
2. Drainage at tree pits: If directed by the Engineer, check drainage at tree pits prior to planting, by performing percolation tests (in dry weather) as follows:
   a. Dig out planting hole to required depth and fill hole half full of water. Monitor decrease in water level to determine if drainage is appropriate for soil type. Soils in wetter areas will drain more slowly that soils in dryer areas.
   b. If water does not drain adequately from plant pits, amend conditions at tree pits and planting beds as required for satisfactory drainage. If topsoil or subgrade has been over-compacted by the Contractor's operations, such as by compaction equipment or by allowing vehicles or equipment to pass over the area, the Contractor shall remove and replace over-compacted materials at its own expense.
   c. Obtain approval of Engineer for proposed amendments.
   d. Do not place trees in pits until approval of drainage conditions by the Engineer.
3. The Contractor shall be liable for all damage to surrounding areas caused by planting operations and shall be required to restore or replace the damaged areas to their original condition.
4. Contractor is responsible for determining the location of all utilities, by contacting the appropriate utility company prior to any planting activities.
   a. Verify that underground utilities and irrigation systems in landscape areas are in place, at the proper location, tested (except final irrigation testing) and ready for use.
      1) Take proper precautions so as not to disturb or damage sub-surface elements.
   b. Coordinate with other trades.
5. The Contractor is liable for any damage to such utilities during the course of construction, and is responsible for making necessary repairs to damaged utilities at its own expense.

6. Approximately one (1) month prior to the expiration of the guarantee period, the Contractor shall arrange a Site inspection by the Engineer.

7. At this time, the Engineer will prepare a list of all remedial Work required, including plant replacement and maintenance.

8. This Work shall be carried out before the end of the guarantee period, unless weather conditions cause delays, in which case such Work shall be carried out as soon as is practical, as determined by DEP.

C. Preparation

1. Planting

a. Install filter fabric under planted areas, in areas shown on the Drawings.

1) Fabric shall be overlapped by a minimum of six (6) inches.

2) Fabric shall be held in place with wire staples of adequate quantities to prevent movement of fabric during planting operations.

3) Fabric ends shall be secured in trenches as shown on the Drawings.

4) No fabric shall be visible following completion of planting and seeding operations.

b. Planting soil mix materials and installation shall be as specified in Section 32 90 05 – Soil Mixes.

c. Exercise extreme caution during excavation to avoid damaging or interrupting existing underground utilities. Use appropriate detection equipment to locate utilities during excavation for planting.

d. Erect barricades, warning signs, or other protective devices as may be required by local, state, or federal Laws and regulations to protect open excavations.

2. Seeding and Sodding

a. All areas to be seeded or sodded shall be thoroughly loosened to a depth of 6 inches and graded to true lines free from all unsightly variations, bumps, ridges or depressions. All sticks, stones, roots or other objectionable material shall be removed.

e. Provide 4 inches of lawn soil mix, spread evenly over all areas to be seeded or sodded. Prepare topsoil to provide a crumbly seedbed, firm and level after tilling.

f. After all materials have been worked in, firm up soil by rolling to eliminate all soft spots. Rake entire area into a crumbly state, with one inch of loose soil at the surface, using a wide-toothed rake or tine-harrow.

g. For additional requirements on the use of soil amendments, refer to Section 32 90 05 – Soil Mixes.

3.02 INSTALLATION

A. Plant only within the following dates, weather permitting. Do not plant in times of high wind, rain, sleet, or snow when the ground is frozen or excessively wet; or when the soil is otherwise in an unsatisfactory condition for planting. Planting at times other than those specified will be at the Contractor's own risk, and will not invalidate any guarantees.

1. Deciduous trees and shrubs:

a. Spring: March 15 to May 15

b. Fall: October 1 to November 15

2. The following trees shall be planted during the spring season only:

a. Acer rubrum and A. saccharum

b. Betula lenta, B. allegheniensis and B. populifolia

c. Carpinus caroliniana

d. Carya spp.

e. Castanea dentata

f. Cornus alternifolia and C. florida

g. Liriodendron tulipifera

h. Nyssa sylvatica

i. Ostrya virginiana

j. Pinus rigida and P. strobus

k. Quercus spp., except Q. palustris or Q bicolor

l. Salix amygdaloides

m. Sorbus americana

n. Tilia americana

o. Tsuga canadensis

p. Viburnum lentago and V. prunifolium

q. Betula sp.

r. Crataegus sp.

s. Liquidambar styraciflua

t. Liriodendron tulipifera

u. Platanus acerifolia

v. Prunus sp.

w. Quercus sp.

x. Salix babylonica

y. Tilia tomentosa

z. Zelkova sp.

3. Evergreen trees and shrubs

a. Spring: April 1 to May 30

b. Fall: September 1 to October 15

4. Herbaceous plants:

a. Spring: March 5 to May 30

b. Fall: August 15 to September 15

5. Seeding, hydroseeding, and sodding shall be carried out during the following dates:

a. Warm season grasses:

1) May 1 to July 15

b. Cool season grasses:

1) Spring: April 1 to June 1

2) Fall: September 1 to October 15

6. Seeding shall be in moderately dry to moist soil, at such times when wind does not exceed five (5) miles per hour.

B. Do not plant until plant material has been approved by the Resident Engineer at the Site.

C. If planting is delayed more than 6 hours after delivery, provide adequate means of protection from freezing and from the drying effects of wind and sun.

1. Protect root balls with soil, wet mulch, or other acceptable material.

2. Provide shade structures or other covering as required to protect from sunscald.

3. Water as necessary until planted. Do not allow plant material to wilt or show signs of stress from lack of water. Provide all water

and equipment for water distribution at no additional cost to the City.

4. Do not remove container-grown stock from containers prior to planting.

D. Placement of Plants

1. All trees, shrubs, groundcovers, vines and herbaceous material shall be laid out in random and naturalistic arrangements, unless otherwise directed by the Engineer. All plant and planting area locations shall be staked prior to planting. No plantings shall be placed within 2 feet of pavements or structures, unless otherwise indicated on the Contract Drawings.

2. Plants shall be set in the center of pits, plumb and straight, in accordance with the planting details, and faced to give best appearance and relationship to adjacent plants and structures.

3. Plant to such depth that the finished grade level of plant, after settlement, will be the same as that at which the plant was grown.

4. Trees must be planted at the depth of the flare, where roots spread from the trunk. The flare must be located and placed at the correct level before continuing planting operations.

5. All planted areas shall be seeded with Underplanted Mix, as specifying in section 2.02.

E. Planting Trees and Shrubs

1. Excavation for planting shall be semi-circular with sloping sides. The diameter shall exceed by at least 2 times the diameter of the ball in balled and burlapped plant material. The diameter of the planting pits for bare root plant material shall be at least 1 foot greater than the root spread. The planting pits for containerized plant material shall exceed the diameter of the container by at least 12 inches. Pits shall be dug deep enough to sufficiently accommodate the ball in balled and burlapped plant material or the height of the containerized plant material. For bare root material, the pit for the transplant shall be dug deep enough to accommodate the entire length of the root. In no case shall roots be bent into a hole that is too shallow. Roots shall be spread out to maximize contact with soil. The minimum depth of pits for all shrubs and vines is 16 inches; this depth shall be increased sufficiently to accommodate the ball or roots.

2. Excavations for trees and shrubs shall be filled with water and water shall be allowed to percolate out before planting.

1. If plant pits are mechanically dug, the sides of the pit shall be broken down or roughened with a shovel or other hand tool to eliminate surface glazing.

3. Remove any platforms, wire, and surplus binding from top and sides of ball.

4. Position plants in center of pit, using gentle handling to avoid damage to any part of the plant.

5. Set plants on a bed of compacted soil mix, to position at the correct depth, as shown on the Drawings.

6. Cut and remove burlap, rope ties, and wire baskets from the root ball, backfilling and gently removing burlap and wire basket in sections as needed to support the root ball.

7. If wire baskets are used to contain the root ball, these shall be entirely removed before planting.

8. Cleanly cut off all visible broken or frayed roots.

9. Add mycorrhizal fungi inoculant, if specified, to each tree planting as per the approved manufacturer's or supplier's instructions.

10. Apply water retention additive as per approved manufacturer's or supplier's instructions.

11. Backfilling: Fill plant pit with soil mix by hand, in layers not more than six (6) inches deep, and with each layer thoroughly settled by hand tamping and with water, and free of all voids before next layer is put in place.

12. Install tree irrigation bags and fill with water, unless otherwise specified or directed by the Engineer.

F. Planting Perennials

1. Excavate plant holes to depth of container and twice the container diameter.

2. Carefully remove plant from container using gentle handling to avoid damage to any part of plant.

3. If roots are loose, spread roots out evenly over a mound of soil mix. If roots are tight and compact, loosen by pulling gently apart. If plant roots will not separate, use a sharp tool to make vertical slits in the root ball, approximately 1/2-inch deep at three or four locations around root mass.

4. Set plants on a bed of compacted soil mix, so that the root ball is level with the surface of the soil.

5. Backfilling: Fill plant pit with soil mix by hand, pushing the mix around and just over the surface of the root ball. Add soil mix in layers not more than four inches (4") deep, and with each layer thoroughly settled by hand tamping and with water, and free of all voids before next layer is put in place.

G. Saucering

1. After backfilling is completed, a saucer shall be made for the retention of water around each plant, unless impracticable because of placement of tree gratings or other paving material over planted area.
2. The saucer shall be of the same diameter as that of the hole dug.
3. The lip shall be level all around and shall be at least 4 inches high for trees, and 2 inches high for shrubs.

H. Watering

1. Immediately after installation of each plant, the soil around it shall be thoroughly saturated with water.
    a. Apply water slowly so as to penetrate the entire root system.
    b. Watering shall continue throughout the maintenance and guarantee period, as frequently as seasonal conditions require, until Final Acceptance of the Work.
    c. Contractor shall be responsible for adequate water both before and after installation of irrigation system.

I. Mulching

1. After planting operations are complete all plant bed areas shall be covered with approved mulch.
    a. Unless otherwise specified on the Contract Drawings, mulch shall be installed at an even depth of three (3) inches over tree pit and shrub areas and two (2) inches over groundcover beds.
    b. Mulch shall be contained within the plant bed areas and shall not be permitted to spread onto paved areas. Mulch shall not cover plants.
    c. Mulch shall not be placed in direct contact with tree trunks. The area of the root flare shall be left free of mulch.

J. Staking

1. Trees shall be staked only if shown on the Contract Drawings, required in the Contract, or directed by the Engineer.

a. Trees shall stand plumb after staking.

b. Do not use tree wrap.

K. Pruning

1. Perform pruning following planting only as shown on the Contract Drawings, required in the Contract, or directed by the Engineer and approved by the City.

a. Excessive pruning at the time of transplanting shall be avoided.

b. Pruning shall be performed by a Certified Arborist in accordance with current best practices of the International Society of Arboriculture.

c. All deadwood and broken or damaged branches shall be removed. Plants exhibiting suckers should be rejected.

d. Pruning shall be done with clean, sharp tools.

e. No leaders shall be cut. Each cut shall be made carefully, at the correct location, leaving a smooth surface with no jagged edges or torn bark. The correct anatomical location is just beyond the branch collar.

f. Large or heavy limbs shall not be removed.

L. Antidesiccant Spraying

1. Use antidesiccant only as approved by Engineer. Approval is required for each condition of use.

3.03 FIELD TESTING / QUALITY CONTROL

A. Protection and Maintenance

1. At least 30 days prior to the date of the written request for Substantial Completion, the Contractor shall submit a written protection and maintenance program and schedule to the Engineer for approval.

2. Protection and Maintenance program shall be revised and resubmitted as required until approved by Engineer.

3. During the guarantee period, the Contractor shall maintain all plant materials as specified herein, and as noted in the approved maintenance schedule, and shall replace, at no additional cost to the City, any and all plant material that has died or, in the opinion of the Engineer or Engineer's designated representative, is in unhealthy or unsightly condition.

4. The Contractor is responsible for providing and maintaining adequate protection measures for all planted areas throughout the

guarantee period in order to protect plantings from any subsequent construction operations or other types of physical damage.

a. Protection measures may include, but not be limited to, approved temporary fencing, tree guards, signage and other measures as determined to be necessary during the guarantee period.

b. Local fence ordinances and guidelines may also apply to the Work, requiring the Contractor to submit design drawings or other documents for obtaining the necessary local permits or approvals at no additional cost to the City.

5. Meadows will be evaluated toward the completion of the first full growing season following installation. Scattered bare spots, none of which are larger than 1 square foot, will be allowed up to a maximum of 3 percent of any meadow, for the purpose of establishing an acceptable standard. Meadows must be weed-free at final acceptance.

B. Replacements

1. There will be no limit to the number of times replacements are made of individual plants, unless conditions causing the failure can be proved to be beyond the control of the Contractor.

2. The Contractor is responsible for replacing any and all plant material and any associated compacted soils that are damaged by the Contractor's own operations or the operations of any of its Subcontractors, or due to other damage resulting from a lack of adequate protective measures, at no additional cost to the City.

3. All replacements shall be in accordance with original specification or, if it is determined that specified plants are inappropriate for as-built conditions, they may be replaced with the approval of Engineer to more appropriate species as identified by a DEP Restoration Specialist, Landscape Architect or other qualified professional.

4. Cost of all replacements shall be included in the Contract price. No additional payment will be made therefor.

5. Replace unacceptable plant material no later than the next succeeding planting season.

6. All areas damaged or soiled by replacement planting operations are to be fully restored to their original condition at no additional cost to the City.

C. Substantial Completion

1. Contractor shall submit a written request to the Engineer, for a formal inspection of the planting Work for Substantial Completion.
2. To be accepted at the time of formal inspection of planting Work, all plant material must be alive, healthy, and installed as specified.
    a. If plants are dead, dying, or unhealthy, or if landscaping does not serve its visual or soil stabilization functions, or if workmanship is unacceptable to the Engineer or Engineer's Representative for other reasons, written notice will be given to the Contractor in the form of a punch list that itemizes all remedial Work required for Substantial Completion.
    b. This Work may include plant replacement or maintenance which must be carried out prior to issuance of the Certificate of Substantial Completion.
    c. The Certificate of Substantial Completion will not be issued until a written maintenance program, as described herein, has been approved by the Engineer.

D. Final Acceptance

1. Following the completion of all remedial work and replacement plantings, the Contractor shall request the Engineer in writing for a formal inspection of the landscape Work for Final Acceptance.
2. If replacement plantings are required, Final Acceptance will be given upon a final inspection at the end of the guarantee period for the plant replacements.

E. All of the materials and labor required for plant protection, maintenance and replacements during the guarantee period shall be included in the Contractor's bid price. No additional payments will be made therefor.

3.04 STARTUP / DEMONSTRATION

A. Sodding Operations

1. Water the prepared soil bed between 12 and 24 hours prior to sod installation, sufficient to evenly moisten the soil mix, without over-watering or causing slipperiness.
    a. Watering shall be carried out after the completion of soil mix placement, grading, settlement of soil surface, completion of remedial work and application of soil amendments.
2. Lay sod strips, after watering as specified, perpendicular to slope and edge to edge.
    a. Place first row of sod in a straight line.

b. Place all subsequent rows parallel with joints butted tightly together and with staggered ends of sod strips.

c. Perimeter and border areas shall not be laid with less than full width sod or with less than one-half length sod.

d. Handle and lay without stretching of sod material.

e. All ends, joints and cuts shall be fitted and tightly joined so there are no voids or overlaps.

f. The final appearance shall be of a continuous lawn.

3. Tamp the sod lightly to ensure good contact with the soil surface and remove, replace, and re-tamp places of minor depressions or irregularities.

4. Finished grades at sod lawn areas shall be within one (1) inch of finished grades indicated on the Contract Drawings, except where lawn meets paved areas, there shall be no change of grade between lawn and pavement.

a. Finished grades shall allow free flow of surface drainage to catch basins without ponding.

5. Top Dressing

a. Following completion of all sod laying, the sod surface shall be top dressed with Lawn Soil Mix, conforming to Section 32 90 05 – Soil Mixes.

b. The soil mix shall be screened to remove all materials larger than 1/2-inch.

c. Soil Mix material shall be worked into the seams between the sod pieces with a brush.

d. When finished, the sod shall present a smooth and uniform surface parallel to the finish grade.

e. Water all sod areas immediately following sod installation so that the sod surface and sod bed surface are thoroughly soaked.

B. Seeding Operations

1. Prepare seedbeds in undisturbed areas by lightly tilling or harrowing to a depth of two (2) inches. No fertilizer is to be applied to wildflower or native grass areas. Prior to preparation of undisturbed sites, remove existing grass, vegetation and turf. Contractor shall take particular care so as not to damage existing plant material adjacent to seeding area while preparing seed bed. Dispose of removed vegetation off-site in accordance with all local

Laws; do not turn over into soil being prepared for native grass and wildflower seeding.

2. Moisten prepared seeding areas before planting if soil is dry. Do not create a muddy soil condition.

3. Apply seed with drop or cyclone spreader to uniformly cover seedbed at the manufacturer's suggested rate. In general, spring and summer seeding will be at a rate of 30 lbs./acre and winter seeding at a rate of 100 lbs./acre, per NYSDEC guidelines.

4. Small wildflower seeds should be mixed with damp sand and hand sown. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over the entire area.

5. Lightly rake seed into soil, and cover entire area with salt hay or straw, to a thickness of one (1) inch. For larger areas, a mechanical power drawn seeder or combination grass planter and land packer or pulverizer may be used. Seed to be planted not deeper than 1/4 inch. Seeding operations shall be kept as close as possible to the contours and not up and down the slopes.

6. Quick growing cover annual crop should be applied at the manufacturer suggested rate.

7. Water all seeded areas immediately upon installation, taking care not to wash out the seeds, and regularly during first four (4) weeks following seeding to maintain adequate moisture for deep root growth.

8. Seeding shall not be done on frozen ground or when the temperature is 32^{o} F or lower. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.

9. Seeded areas shall be protected during establishment.

C. Hydroseeding

1. All areas to be hydroseeded shall be thoroughly loosened to a depth of 6 inches and graded to true lines free from all unsightly variations, bumps, ridges or depressions. All sticks, stones, roots, or other objectionable material shall be removed.

2. Provide six (6) inches of soil mix and spread evenly over all areas to be hydroseeded. Prepare topsoil to provide a crumbly seedbed, firm and level after tilling. For additional requirements on the use of crushed limestone in the soil mix, see Section 32 90 05 – Soil Mixes.

3. Apply hydroseeding solution with a mobile tank with a centrifugal pump, using a seeding nozzle of a design to produce an even distribution of the solution

4. Clean and remove all hyrdoseeding solution from areas outside of the limits of hydroseeding, including removal from structures, walls, paving, trees and other plant material.

D. Watering of Sodded, Seeded and Hydroseeded Areas

1. The Contractor shall provide all labor and arrange for all watering necessary to establish acceptable stands of planting in seeded areas.

   a. Begin watering immediately following installation.

   b. Watering shall continue throughout the Contract period until Substantial Completion.

   c. During the first two (2) weeks after planting, in the absence of adequate rainfall, watering shall be performed up to three (3) times daily or as often as necessary and in sufficient quantities to maintain moist soil to a depth of at least two (2) inches.

   d. After the first two weeks, the Contractor shall water the seeded areas to maintain adequate moisture in the upper two (2) inches of soil, necessary for the promotion of deep root growth.

2. Watering shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply one (1) complete coverage to the lawn areas in an eight (8) hour period.

E. Reseeding

1. Any areas that fail to show growth within three (3) weeks of seeding shall be immediately reseeded at no additional cost to the City.

2. Reseeding shall be carried out as many times as necessary until a uniform grass cover is established.

3. Scattered bare spots, none of which are larger than one square foot, will be allowed up to a maximum of 3 percent of any seeded or hydroseeded area.

F. Mowing

1. Mowing of all seeded, hydroseeded and sodded lawn areas shall begin when grasses and other plants are firmly rooted and secure, and shall continue until Substantial Completion.

2. Mow all grass lawn areas to maintain the grass height between 1-1/2 and 2-1/2 inches and meadow areas up to six (6) inches or as directed by the DEP Maintenance Supervisor.

3. Meadow areas shall be mown no more than two (2) times per year.

   a. First mowing shall be carried out after seed set and shall not be carried out earlier than September 15 nor later than November 15. Mow to a height of not more than 9 inches.

   b. Second mowing shall be carried out four (4) to six (6) weeks after first mowing, unless otherwise directed by DEP. Mow to a height of between 5 and 6 inches

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Adjusting

1. Maintenance of all plant material shall begin immediately after planting, and continue until the end of the guarantee period, unless otherwise noted.

2. Defective Work shall be corrected as soon as possible after it becomes apparent and when weather season permits. The Engineer shall be the sole judge of the condition of the plants.

3. Maintenance shall include:

   a. Watering, replanting, reseeding, resodding, repair of ruts and erosion, repair of protection devices, weeding and continuous control of invasive species, fertilizing and mowing of lawn areas.

   b. The removal of all dead, dying or unhealthy plant material, including lawns, and replacement of such material with new plants or seeding to meet all specifications of the original plantings.

   c. Protection from insects, disease, and invasive species to maintain optimum health. Infection or infestation may require removal and disposal off-site followed by replacement with plants free of infection at the discretion of the Engineer's designated representative.

   d. The repeating of any or all phases of planting or lawn work as specified herein, or that may be required to obtain healthy plantings and a uniform, thick, and well developed stand of grass.

4. Specific Maintenance Tasks: Maintenance shall include, but not be limited to the following:

5. Watering: Water lawns and planted areas as required. Do not permit plant material to wilt or to show signs of stress from lack of water. Contractor shall supply and distribute water to all lawns and plantings during the full time of their establishment at the Site and provide all equipment for water distribution at no additional cost to the City. Plants and lawns shall be inspected by the Contractor for watering needs at least once each week, and watered as necessary to promote plant growth and vitality.
6. Mowing: As described hereinbefore.
7. Fertilizers: If applicable, apply any approved fertilizers, herbicides, pesticides or fungicides as required, or as directed by the Engineer, to keep all plantings healthy and pest-free throughout the guarantee period. Any fertilizers, herbicides or pesticides must be approved in advance by DEP.
8. Rodents: Protect against and exterminate rodents, and repair of any damage caused by rodent activities.
9. Weeding: Weed to keep all planted areas weed-free throughout the guarantee period.
10. Mulching: Add mulch material as required to maintain mulch at specified depth.
11. Resetting: Reset plant material that has settled, to proper grade and position.
12. Pruning: Prune trees and shrubs to remove all dead or broken branches, throughout the guarantee period. Prune flowering shrubs as necessary to ensure flowering.
13. Trimming: Cut back dead stalks, flowers and foliage from perennials in fall after the first frost. Trim or dead-head spent flower blossoms throughout the guarantee period.
14. Anchoring: Maintain any approved tree stakes, ties and other tree anchoring systems, including tightening, repair or replacement as required, and removal at the end of the guarantee period, or as directed by the Engineer.
15. Irrigation: If applicable, coordinate with irrigation system installer for all adjustments to irrigation as required.
16. Instruct City’s maintenance personnel in all maintenance procedures.
17. Maintenance Program
    a. Prior to Substantial Completion, the Contractor shall arrange a meeting with the Engineer and with the City's

designated maintenance personnel to review together the submitted maintenance program and any modifications required for the duration of the guarantee period.

b. The Contractor shall make periodic inspections, at no extra cost, during the guarantee period to determine what changes, if any, should be made in the maintenance program.

c. Any recommended changes shall be submitted in writing to the Engineer.

d. Additional remedial work not included in the maintenance program shall be carried out by the Contractor as deficiencies are identified and reported by the Engineer or designated maintenance personnel.

18. Replacements

a. In accordance with the requirements for Warranty (Guarantee Period) under this Section, the Contractor shall replace, as soon as weather conditions permit, and within a specified planting period, all plants determined dead and/or dying by the Engineer or the City's designated personnel during and at the end of the guarantee period. Replacements shall be made at no additional cost to the City. Labor and all materials needed for installation of replacements shall be included in the warranty.

b. Plants shall be free of dead or dying branches and shall bear foliage of normal density, size, and color.

c. Trees having lost their central leader or exhibit crown dieback at the end of the guarantee shall be replaced.

d. Replacements shall match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this Section.

B. Plant Protection

1. The Contractor shall provide at its own expense all protection that is deemed necessary for all plants and lawn areas against damage prior to Final Acceptance.

2. Removal of Temporary Protection Measures: All temporary protection measures employed during the construction period shall be removed prior to Substantial Completion unless otherwise directed by the Engineer. All stakes and ties used for temporary bracing of trees shall be removed and disposed of by the

Contractor off site at its own expense at the end of the guarantee period, or earlier at the direction of the Engineer.

C. Clean Up

1. At the end of each work day the Contractor shall broom-clean the Site, to remove all trash, debris, and loose soil materials. Store materials and equipment where directed.

2. Immediately following the completion of planting operations, the Contractor shall remove all excess materials, stockpiles, waste materials, tools, and equipment, and leave the Site in a clear and clean condition.

3. Immediately remove all rejected materials from the Site. All rejected materials and other waste or debris shall become the property of the Contractor, who shall legally dispose of same off-site.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The work of this Section includes but is not limited to the following:

1. Supply of component materials and soil amendments for soil mixes or supply of blended soil mixes from approved off-site sources.
2. Reuse of existing topsoil stripped from site.
3. Preparation of soil mixes on site.
4. Installation, placement, spreading, and fine grading of soil mixes.
5. Testing of all soil component materials, soil amendments, and soil mixes.

B. The Contractor shall implement practices and procedures to meet the Project's sustainability goals as identified in the Contract Documents. The Contractor shall ensure that the sustainability requirements of this Section are implemented to the fullest extent.

C. The following index of this Section is presented for convenience:

D.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 31 23 16 -- Excavation

B. Section 31 23 23 -- Fill

C. Section 31 25 10 -- Dust, Soil Erosion and Sediment Control

D. Section 32 90 00 -- Planting

1.04 REFERENCES

A. ASTM International (ASTM) Standards

1. ASTM D1556 -- Standard Test Method for Density and Unit Weight of Soil in Place by Sand Cone Method

2. ASTM D1557 -- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

3. ASTM D3385 -- Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometers

4. ASTM D4318 -- Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils

5. ASTM D6938 -- Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

6. ASTM F1647 -- Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes

B. The Northeast Coordinating Committee for Soil Testing

1. NEC-1012 -- Recommended soil testing procedures for the Northeast United States, Northeastern Regional Publication Number 493

C. The New York City Department of Health and Mental Hygiene

1. Local Law 37 Pesticide Use by City Agencies – Pesticide Product Search https://a816-healthpsi.nyc.gov/ll37/ProductTestPesticide.aspx

D. The New York State Pesticide Product, Ingredient and Manufacturer System (PIMS) http://pmep.cce.cornell.edu/pims/index.html

E. New York State Department of Environmental Conservation (NYSDEC)

1. 6NYCRR Subpart 360-5, Composting Facilities

2. 6NYCRR Subpart 375-6, Remedial Program Soil Cleanup Objectives

3. 6NYCRR Part 360 Part 360, Solid Waste Management Facilities

1.05 DESCRIPTION

A. System Design Requirements

1. All soil mix components shall be tested and approved prior to incorporation into blended soil mixes.

2. Provide adequate quantities of all soil mix materials to attain, after compaction and natural settlement, all design-finished grades.

3. Sustainable Design Requirements

a. Regional Materials: Soil shall be extracted within 250 miles of the Project Site.

1.06 QUALITY ASSURANCE

A. Contractor shall submit written test reports as required in this Section.

1. Testing shall be carried out by an independent testing laboratory.

2. Engineer's approval of the testing laboratory shall be obtained by the Contractor before it is given any work of this Section.

3. Contractor shall be responsible for timely submittal of samples to the testing laboratory.

B. Each test shall be carried out using the categories and sieve sizes as specified herein. Failure to include any of the required criteria will be sufficient cause for rejection of the test.

C. Each test report shall include the following information:

1. Project title

2. Name of Contractor

3. Name of material supplier or location where material is extracted from

4. Testing laboratory name, address and telephone number

5. Type of test

6. Date of test

7. Test results, including identification of deviations from acceptable ranges.

D. Each sample shall be tested, as applicable, for the following:

1. Mechanical analysis: Sieve method, using sieve sizes specified.

2. pH should be measured according to Recommended Soil Testing Procedures for the Northeastern United States (NEC-1012). Where soil will be used to support plant growth, lab analysis results must include corrective recommendations.

3. Organic matter content: Percentage of oven-dry weight of soil, determined by loss on ignition of moisture-free sample, in accordance with Method A of ASTM F1647.

4. Electrical conductivity (soluble salts): Test by saturated paste method in deciSiemens per meter (dS/m).

5. Soil Fertility Analysis: Analysis for available macronutrients including, at a minimum, phosphorus and potassium in parts per million according to methods as specified in NEC-1012. Test methods and fertility recommendations must be included with results.

6. Chemical Analyses shall include the 6 NYCRR Part 375-6 compounds detailed in Specification 02 24 20 - Soil Sampling and Analysis. All analyses shall be performed by a testing laboratory certified by the New York State Department of Health Environmental Laboratory Accreditation Program (NYSDOH-ELAP). The frequency of testing per volume of fill shall be in accordance with 6 NYCRR Part 360.13 (e)(1), Table 1, Minimum Analysis Frequency for Fill Material.

   a.

E. The Engineer may take and analyze at any time, such additional samples of materials as deemed necessary for verification of conformance to specification requirements. Contractor shall furnish samples for this purpose upon request and shall perform testing as requested at no additional cost to the City.

F. No component bulk material for soil mix shall be used or blended into a mix, until test reports have been received and approved by the Engineer. As necessary, make any and all soil mix amendments and resubmit test reports indicating amendments, until approved.

G. Comply with all rules, regulations, laws and ordinances of local, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary for work to comply with such requirements at no additional cost to City.

H. Procure and pay for all permits and licenses required for the Work of this Section.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Manufacturer's technical information, including application instructions where relevant, for all soil amendment materials required.

   a. Fertilizers

   b. Soil Inoculants

   c. Herbicides

   d. Water-absorbent Polymer

2. Samples of Soil Mix Components (1-pound package each):
    a. Topsoil -- offsite imported material
    b. Topsoil -- stripped from site
    c. Compost
3. Samples of Blended Soil Mixes (1-pound package each):
    a. Planting Mix
    b. Lawn Mix
    c. Aquatic/Marginal Mix
    d. Engineered Soil
4. Test Results for Soil Mix Components (written report for each bulk component):
    a. Topsoil -- offsite imported material
    b. Topsoil -- stripped from site
        1) For topsoil that is being used for landscaping in package 2 (E&SC Phases 1-3) the Contractor shall provide at least one topsoil test for each E&SC phase as shown in the Contract Drawings.
    c. Sand
    d. Compost
5. Test Results for Blended Soil Mixes (written report for each blended soil mix):
    a. Planting Mix
    b. Lawn Mix
    c. Aquatic/Marginal Mix
    d. Engineered Soil
6. Sources and Manufacturers List: Submit a full list of sources and manufacturers of soil mixes, including component materials and soil amendments.

B. Sustainable Design Submittals:
1. Regional Materials: Provide the following information:
    a. Names of product and manufacturer
    b. Material cost breakdowns. Cost breakdowns must include total material-only cost (excluding installation, labor and equipment).

c. Indicate the location and distance from the Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. (For assemblies, include the percentage by weight that is considered regional.)

1.08 DELIVERY, STORAGE, AND HANDLING

A. Conform to all governmental regulations in regard to the transportation of materials to, from, and at the job site, and secure in advance such permits as may be necessary.

B. Packaged Materials: Deliver packaged materials to the location where planting soil mixes are to be blended, in unopened bags or containers, each bearing the name and trademark of the producer, material composition, manufacturers' certified analysis, and the weight of the material.

1. All bags shall be protected from water and contamination with other materials.

2. Retain packages for inspection by Engineer.

3. All packaged materials shall be stored, handled and applied in strict accordance with manufacturer’s instructions.

C. Stockpiles

1. Contractor shall employ all means necessary for stockpile maintenance to prevent unstable, noxious or anaerobic conditions including, but not exclusive to, temperature monitoring, planting, stockpile repacking, and runoff control.

2. All stockpiled materials shall be adequately handled as required in Section 31 25 10 – Dust, Soil Erosion and Sediment Control.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fertilizer shall be as manufactured by:

1. Osmocote®, The Scotts Company, Marysville, OH;

2. Meister®, The Scotts Company, Marysville, OH;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Topsoil - Offsite Imported Material

1. Imported topsoil or soil blends may not be mined from soils defined by the Natural Resources Conservation Service as prime farmland, unique farmland, or farmland of statewide importance. Imported topsoil shall be:

   a. Of uniform quality, free from hard clods, stiff clay, hardpan, sods, roots, chips, sticks, partially disintegrated stone, cement, ashes, slag, concrete, tar residues, tarred paper, boards, or any other undesirable material. No topsoil shall be delivered in a frozen or muddy condition.

   b. Free from refuse, material toxic or otherwise deleterious to plant growth, seeds, or other viable propagules of invasive plants. Construction and demolition debris as classified under 6 NYCRR Part 360, other than uncontaminated land clearing debris, shall not be used to amend topsoil.

   c. Free of stones over 1 ½ inches in diameter, and will have less than 10 percent gravel.

2. Topsoil shall conform to the following requirements:

   a. pH 5.5 to 7.0

   b. Organic content 4 - 6%

3. Topsoil shall conform to the following mechanical analysis:

Sieve Size	Percent Passing
1"	100
1/4"	90 - 99
# 10	80 - 100
# 40	40 - 60
# 60	40 - 60
# 100	10 - 30
# 200	10 - 20

4. When the topsoil otherwise complies with the requirements of the specification but shows a deficiency of not more than one percent (1%) organic matter content; then humus, compost, or other approved organic matter may be incorporated when or as permitted by the Engineer.

5. Topsoil shall not contain hazardous waste, petroleum spills or other chemical releases, or industrial waste. Any shipment of topsoil that does not meet this requirement will be rejected by the Engineer and shall not be brought on site.

6. Topsoil being brought on Site shall be sampled and must meet the definition of General Fill as defined in NYSDEC 6 NYCRR Part 360.13 (f), Table 2: Fill Material Beneficial Use, unless otherwise approved by the Engineer. Topsoil to be used in ecologically sensitive sites (e.g., wetlands) shall meet the SCOs for the protection of Ecological Resources, unless otherwise approved. See Section 31 23 23 – Fill.

B. Topsoil - Stripped from Site

1. Reuse of topsoil stripped from Site shall be used for this Work when feasible, provided it meets:

   a. All the requirements of physical properties for imported topsoil as specified hereinbefore; and

   b. The requirements for beneficial use of excavated soil as specified under 6NYCRR § 360-1.15(b). See Section 31 23 23 -- Fill.

C. Compost

1. Shall conform to the following requirements:

   a. Material shall be capable of sustaining the growth of vegetation, with no admixture of refuse or material toxic to plant growth.

   b. Material shall be derived from organic wastes such as food and agriculture residues, composted cow or other animal manures, sewage sludge or other materials that meet the specified requirements.

   c. Material shall be screened, and shall be free of any stones, branches, roots, brush, weeds, or wood chips, and all debris such as plastic fragments, glass, and metal fragments.

   d. Organic content: 50% minimum.

   e. pH: 5.5 to 8.0.

   f. Carbon/nitrogen ratio: 25:1 to 35:1.

   g. 100% passing 1/2" screen .

2. Compost shall meet the requirements for “Monthly Average Concentration” pollutant limits, except where the Engineer specifically allows the use of the “Maximum Concentration” pollutant limits, as stated in the current version of 6 NYCRR Part 360.

3. No compost shall be delivered until the approval of samples by the Engineer, but such approval does not constitute Final Acceptance. The

Engineer reserves the right to reject, on or after delivery, any material which does not, in their opinion, meet these specifications. When compost is stored on the job, it shall be done as directed by the Engineer.

4. Certification: Only facilities permitted to compost biosolids under 6 NYCRR Part 360, will be allowed to furnish finished compost for use in topsoil. The certification shall be supplied by the Contractor prior to the delivery of any composted biosolids, topsoil containing sewage sludge, or other such regulated material to the site.

D. Soil Amendment Materials: Within the watershed, fertilizers shall not be used unless a soil test indicating a need for soil amendment is provided. Recommended materials below may not be used except where they fulfill amendment requirements. Where authorized for use in the Contract Documents, or by written direction of the Engineer, Soil Amendment Materials shall have the following compositions:

1. Soil Fertility Analysis: Available macronutrients including Phosphorus and Potassium should be adequate to support the intended plant community. Available macronutrients shall not be at excessive levels that could potentially impair plant growth or impact water quality. The determination as to whether available nutrients are low, optimum, or excessive shall be made and reported by the soil testing laboratory based on extraction and test methods used.

   a. Only when soil analysis indicates a need and if approved in advance by the Engineer, apply commercial fertilizer and uniformly work in to top one inch of seedbed. The rate of application shall be determined by soil analysis.

   b. Do not apply superphosphate except where specifically indicated and as approved by the Engineer. Where required, uniformly work in to top one inch of seedbed. The rate of application shall be determined by soil analysis.

2. In addition to obtaining the Engineer's approval of the type(s) and N-P-K (Nitrogen-Phosphorus-Potassium) analyses of soil amendment materials, proposed based on soil test results, the Contractor shall meet the following requirements:

   a. Bonemeal: Shall be finely ground.

   b. Commercial Fertilizer: A minimum of 50% of the nitrogen shall be derived from organic sources.

   c. Controlled-release Fertilizer: Shall be in granular form.

3. Limestone: Shall be granular limestone, produced from Dolomitic limestone specifically for use in planting, with a minimum of 88% of calcium and magnesium carbonates, conforming to the following requirements:

Sieve Size	Percent Passing
# 10	100
# 20	90 minimum
# 100	60 minimum

4. Only when chemical analysis indicates a need and where approved by the Engineer, apply ground limestone and uniformly work in to top one inch of seedbed. The rate of limestone application shall be dependent on the pH of the soil, as determined by chemical analysis, and shall be as follows:

pH of Soil	Rate: Pounds/1000 Square Feet
5.0 to 5.5	100
5.5 to 6.0	50
6.0 to 6.8	25
over 6.8	0

5. Sulfur: Lower pH if required, by use of elemental sulfur product.
   a. Peat moss or copper sulfate may not be used to lower pH.
6. Mycorrhizal Fungi Inoculant
   a. For tree plantings, the Contractor shall supply Mycorrhizal Fungi Inoculant, if specified, in granular form such as by means of a three ounce (3 oz.) premeasured dry formulation packet, such as Mycor Tree Saver Transplant®, as manufactured by Plant Health Care, Inc., Pittsburgh, PA, or approved equal.
7. Water Retention Additive
   a. Water Retention Additives for tree plantings shall be a granular polyacrylamide polymer of a potassium base and not a sodium base that slowly releases moisture into the root zone such as Terra Sorb, as manufactured by Plant Health Care, Inc., 440 William Pitt Way, Pittsburgh, Pa., or approved equal.

E. Herbicides and Pesticides shall be in compliance with NYC Local Law 37 of 2005 and in conformance with the guidelines of NYC Department of Health for determining whether a pesticide or herbicide is prohibited by the Law.

F. Planting Soil Mix
   1. Planting Mix shall conform to the following requirements:
      a. Organic Matter: 4.5 % minimum

b. pH: 6.0 to 7.0

c. Electrical Conductivity (soluble salts): 0.7 to 2.0 dS/m

2. Mix shall consist of the following proportions by volume:

a. Six parts topsoil

b. Two parts compost

3. The following items shall be added to the above mix if specified in Contract Drawings or approved in writing by the Engineer:

a. Five pounds bonemeal per cubic yard of soil mixture

b. One pound commercial fertilizer per cubic yard of soil mixture

c. One pound controlled release fertilizer per cubic yard of soil mixture

d. Two pounds water absorbent polymer per cubic yard of soil mixture, or as recommended by manufacturer

e. Ground limestone as required for specified pH

G. Lawn Mix

1. Lawn Mix for all sodded, seeded and hydroseeded lawn areas, shall conform to the following requirements:

a. Organic Matter: 4.5 % minimum

b. pH: 6.0 to 7.0

c. Electrical Conductivity (soluble salts): 0.7 to 4.0 dS/m

2. Mix shall consist of the following proportions by volume:

a. Six parts topsoil

b. Two parts compost

c. Two parts sand

d. One part perlite

3. The following items shall be added to the above mix if specified in Contract Drawings or approved in writing by the Engineer:

a. Five pounds bonemeal per cubic yard of soil mixture.

b. One pound commercial fertilizer per cubic yard of soil mixture.

c. One pound controlled release fertilizer per cubic yard of soil mixture.

d. Two pounds water absorbent polymer per cubic yard of soil mixture, or as recommended by manufacturer.

e. Ground limestone as required for specified pH

H. Marginal/Aquatic Mix

1. Marginal Mix shall conform to the following requirements:

a. Organic Matter: 4 % minimum

b. pH: 6.0 to 7.0

c. Electrical Conductivity (soluble salts): 0.8 - 4.0 dS/m

2. Mix shall consist of the following proportions by volume:

a. Four parts topsoil

b. One part clay

I. Engineered Soil for Bioretention Facility

1. Engineered Soil for Bioretention Facility shall conform to the requirements of the NYSDOT Standard Specifications Bio Soil Mix, item 208.01030022 including the following requirements:

a. 75% Concrete Sand per NYSDOT Standard Spec 703-07

b. 25% Topsoil @ 12% to 28% Organic 713-01 Topsoil, Type A per NYSDOT Standard Spec (see exceptions below)

1) The soil for Bioretention areas and Dry Swales shall be a uniform mix, free of stones, stumps, roots or other objects larger than two inches (2”) in diameter.

c. The Bioretention and Dry Swale soil shall be visibly free of noxious weeds.

d. The Bioretention and Dry Swale Soil shall meet the following:

1) pH range of 5.2 to 7.6,

2) organic content of 3-7%.

3) All topsoil shall be sampled and tested, regardless of the source.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examination

1. Prior to soil mix placement, the Contractor shall examine the Site to determine the status of construction and existing condition in and near the areas to be planted.
2. The Contractor shall ascertain the location of all existing and proposed electric cables, conduits, irrigation, under-drainage systems and all other underground or at grade utilities, by contacting the appropriate utility company. The Contractor shall comply with the requirements of Section 31 23 16 - Excavation prior to any excavation work.
    a. Contractor shall take proper precautions so as not to disturb or damage any sub-surface elements.
    b. Contractor shall be liable for and all damage to such utilities during the course of construction, and shall be responsible for making requisite repairs to damaged utilities at Contractor's own expense.
    c. Contractor shall be liable for any and all damage to surrounding areas caused by planting operations and shall be required to restore or replace damaged areas to original conditions, to the satisfaction of the Engineer.
3. The Contractor shall comply with the requirements of Section 31 25 10 - Dust, Soil Erosion and Sediment Control.
4. The Contractor shall coordinate, adjust, and relate together, work of this Section with other work of the Project and with work of Other Contractors. Such coordination shall include but not be limited to the following:
    a. Scheduling of planting operations
    b. Scheduling of maintenance operations
5. The Contractor shall also:
    a. Verify that all work requiring access through or adjacent to areas where soil mixes are to be placed has been completed and no further access (other than landscape installation) will be required. In the event that access will be required, this must be coordinated with the Engineer.
    b. Perform soil mix blending and site soil work only during suitable weather conditions. Do not handle, haul, place, work, disc or rototill soil when frozen, excessively wet, or in otherwise unsatisfactory condition.

B. Preparation of Soil Mixes

1. Excavation of subgrade shall conform to the applicable requirements of Section 31 23 16 - Excavation.

2. Uniformly blend all ingredients as required for each soil mix type, by wind rowing and/or tilling on a hard surfaced area.

   a. The components of all soil mixes shall be blended so that ingredients are thoroughly incorporated into the mixture to assure uniform distribution.

   b. Do not over-mix, mix shall remain friable and well aerated.

   c. Organic matter shall be maintained moist, not wet, during blending.

   d. Delay mixing of any approved fertilizers if planting will not follow within a few days.

   e. Add mycorrhizal fungi inoculant, if specified, to each tree planting at rate specified by approved manufacturer.

   f. Apply water retention additive as per approved manufacturer's instructions.

C. Preparation of Sub-Grade

1. Verify as-constructed or existing sub-grade elevation and perform additional grading operations as necessary to bring the sub-grade to a true, smooth, slope parallel to the finished grade, at all areas to receive soil mixes.

2. Any sub-grades or soils polluted by gasoline, oil, plaster, construction debris, unacceptable soils, or other substances which would render material unsuitable for plant growth, shall be removed from the premises, at no additional cost to the City, whether or not such pollution occurred or existed prior to or during the Contract period. In the event that such material is placed, this material shall be removed and replaced with approved material. All remedial operations associated with soil mixes shall be reviewed and approved by the Engineer.

3. Clean sub-grade and dispose of all debris prior to placement of soil mixes.

   a. Remove all large clods, lumps, brush, roots, stumps, litter, trash, and other foreign material and stones one-half inch in diameter or larger.

   b. Dispose of removed material legally off-site in accordance with the applicable laws and regulations and the requirements for waste disposal under the Contract.

4. Where specified in contract drawings or approved in writing by the Engineer, spray all vegetation on sub-grade with a pre-emergent weed killer at the rate of application recommended by the manufacturer.

5. Protect adjacent pavements, walls, utilities and other construction from damage or staining by any soil mix placement operations.

3.02 IMPLEMENTATION

A. Placement of Soil Mixes

1. Do not place any muddy or wet Soil Mixes.
2. Place and spread soil mix over sub-grade, to a depth sufficiently greater than the depth required for planting areas so that after settlement the completed work will conform to the lines, grades, and elevations shown or otherwise indicated.
3. Place and spread soil mix over the approved sub-grade, in 6-inch lifts, or as directed by Engineer, and settle to eliminate air pockets and minimize settlement. Lightly scarify previously placed surfaces prior to placing subsequent lifts.
4. Compact to gently with a light or medium weight roller, unless otherwise specified in the Contract Documents.
    a. Fills shall not be so compacted as to restrict the flow of air or water through the soil.
5. After completion of compaction operations, protect the installation from additional compaction from vehicular traffic, contamination by toxic materials or trash, and from water containing cement, clay, silt or any other materials.
6. Any soils that are over-compacted or contaminated after placement or otherwise made unsuitable for plant growth shall be removed from the premises and replaced with approved material or satisfactorily remediated at no additional cost to the City.
7. The Contractor shall also meet the applicable requirements on placement of soil mixes for different planting operations in Section 32 90 00 – Planting.

B. Grading of Soil Mixes

1. After settlement has occurred, add soil to maintain finished grades. If for any reason soil is left exposed for a long duration prior to planting, add soil and regrade as required.
2. Protect placed soil mixes against construction activity with snow fencing or by other acceptable methods.
3. Protect from the eroding effects of wind and rain with filter fabric, as necessary.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Clean up

1. At the end of each work day the Contractor shall broom-clean the site, to remove all trash, debris, and loose soil materials.

2. Immediately following the completion of soil mix installation operations, the Contractor shall remove all excess materials, stock piles, waste material, tools and equipment, and leave the Site in a clear and clean condition.

3. All waste materials shall be disposed offsite by the Contractor in accordance with the applicable laws and regulations and the requirements for waste disposal under the Contract.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials (including sodium hypochlorite and other chemicals), equipment (including taps, corporation stops, temporary pumps, hoses, and miscellaneous piping), and incidentals necessary to perform disinfection of all pipelines, conduits, pumps, tanks, structures, and equipment which are to store, handle, or carry potable water. The Contractor shall remove said materials and equipment after completion of the disinfection procedure. Water for the initial disinfection procedure shall be furnished by the City.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Not Used

1.04 REFERENCES

1. AWWA C651 Disinfecting Water Mains
2. AWWA C652 Disinfection of Water-Storage Facilities
3. International Plumbing Code Section 610 - "Disinfection of Potable Water System."
4. International Plumbing Code Section 606.5.4.5 - "Installation of the Building Water Distribution System - Cleaning or Painting"
5. New York City Department of Health

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

infection shall be in accordance with AWWA C651 for water mains and AWWA C652 for water storage facilities and equipment, except as modified herein. Disinfection procedures for new water mains and water storage facilities shall also conform to the requirements of the International Plumbing Code, Section 610 "Disinfection of Potable Water System" and Section 606.5.4.5 "Installation of the Building Water Distribution System - Cleaning or Painting" respectively, except as modified herein.

1.07 SUBMITTALS

A. Not Used

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 IMPLEMENTATION

A. Pipelines:

1. Pumps, hydrants, and other water handling equipment items that are part of the potable water distribution system shall be disinfected in the same manner as described herein for the pipelines.

2. Pipelines shall first be flushed with clean water. Disinfection shall be accomplished by the Continuous Feed Method, as specified in AWWA C651, using sodium hypochlorite solution.

3. Water-chlorine solution with a concentration not less than 50 mg/l of available chlorine shall then be added at one end of the section being disinfected and discharged at the far end. The water-chlorine solution shall be added until the water coming from each downstream blowoff has a residual of not less than 25 mg/l of chlorine.

4. The pipelines shall then be closed and the solution allowed to remain in the lines for at least 24 hrs. The chlorine residual in the pipeline shall then be rechecked. If the free chlorine residual is less than 10 mg/l after 24 hrs, the procedure shall be repeated until the free chlorine residual after 24 hrs is 10 mg/l or greater.

5. After the 24-hr holding period, the pipelines and equipment shall be thoroughly flushed and filled with clean water. Flushing water shall not be permitted to enter existing water mains.

6. Flushing water shall not be discharged to sanitary or storm sewers without permission of the NYCDEP. Where necessary, Federal, State and local regulatory agencies shall be contacted to determine special provisions for the disposal of heavily chlorinated water.

7. When new potable water pipelines are to be connected to an existing water distribution system, the connecting piping shall be disinfected and tested in accordance with the procedure set forth in Section 9.1 or Section 9.2, as applicable, of AWWA C651.

B. Water Storage Tanks:

1. Potable water storage tanks and other water storage structures shall be disinfected with a solution of sodium hypochlorite and water in accordance with AWWA C652, Method 2 or 3, as modified herein.

2. In Method 2, the spray method, the entire interior surface of the tank or other storage facility, and inlet, outlet and drain piping, shall be sprayed with chlorinated water containing 200 mg/l of available chlorine. The tank shall remain in contact with the strong chlorine solution for at least 2 hrs. Potable water shall then be admitted in sufficient quantity to purge the drain piping of the strong solution. After the drain piping has been purged, the tank shall be filled to the overflow level and allowed to overflow until the chlorine residual drops to approximately 2 mg/l.

3. In Method 3, sodium hypochlorite and water shall be added to the tank in amounts such that the solution will contain 50 mg/l of available chlorine when the tank is filled to approximately 5% of the total storage volume. The solution shall be held in the tank for not less than 6 hrs, after which the tank shall be filled to the overflow level and let stand for not less than 24 hrs. The highly chlorinated water shall then be purged from the drain piping. After the 24-hr period has elapsed, the free-chlorine residual shall be not less than 2 mg/l.

C. Water Supply:

1. Water for the first filling, disinfection and flushing procedure of each pipeline, tank and piece of equipment will be furnished by the City, at no cost to the Contractor, from the nearest hydrant or other source. The Contractor shall provide all necessary apparatus to convey the water to the point of use and perform the disinfection procedure. If the water in the pipelines or storage facility fails the bacteriological tests, water for subsequent disinfection procedures shall be provided by the Contractor. If agreeable to the City, water for the subsequent disinfection procedures may be furnished by the City but shall be metered, and the Contractor shall credit the City for the cost of water used for the subsequent procedures.

3.03 FIELD TESTING / QUALITY CONTROL

A. After the completion of disinfection, bacteriological samples shall be taken by the Contractor and tested at a certified laboratory. Samples shall be taken as required by the New York City Department of Health. The test reports shall be submitted to the Engineer for review and approval. If the samples are not satisfactory, the entire disinfection procedure shall be repeated at the expense of the Contractor until satisfactory samples are obtained.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required, to install all buried piping complete and operational.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 31 23 16 – Excavation.

B. Section 31 23 19 – Dewatering.

C. Section 31 23 23 – Fill.

D. Section 33 05 05.30 – Leakage Testing for Buried Piping.

E. Section 33 06 01 – Schedule for Buried Piping.

F. Section 40 05 06 – Couplings, Adapters, and Specials for Piping.

G. Section 40 05 07 – Hangers and Supports for Piping.

H. Section 40 05 97 – Identification for Process Equipment.

1.04 REFERENCES

A. Definitions:

1.	Buried Piping:	Includes all piping beginning at the outside face of a structures or foundation and extending away from structures. Buried piping includes piping beneath structures or foundations.
2.	Exposed Piping:	Includes all piping beginning at the outside face of a structures or foundation and extending inside. Exposed piping includes interior piping. Exposed piping also includes all piping embedded in concrete, as well as all piping that is permanently or intermittently submerged and/or installed in a subaqueous environment.

B. Reference Standards:

1.	AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe.
2.	AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.
3.	ASME	Boiler and Pressure Vessel Code.
4.	ASME B31.1	Power Piping.
5.	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
6.	ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
7.	ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

8.	ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
9.	ASTM D2564	Standard Specification for Solvent Cements for PVC Plastic Piping Systems.
10.	ASTM D2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
11.	ASTM D2855	Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining PVC or CPVC Pipe and Piping Components with Tapered Sockets.
12.	ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
13.	ASTM F656	Standard Specification for Primers for Use in Solvent Cement Joints of PVC Plastic Pipe and Fittings.
14.	ASTM F2306	Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Non-Pressure Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
15.	ASTM F2487	Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene and Polypropylene Pipelines.
16.	ASTM F2510	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes
17.	AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
18.	AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
19.	AWWA C206	Field Welding of Steel Water Pipe.
20.	AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances.
21.	AWWA C605	Underground Installation of PVC and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

22.	AWWA C606	Standard for Grooved and Shouldered Joints.
23.	AWWA M11	Steel Pipe: A Guide for Design and Installation,
24.	AWWA M23	PVC Pipe – Design and Installation.
25.	AWWA M41	Ductile-Iron Pipe and Fittings.
26.	AWWA M55	PE Pipe - Design and Installation.
27.	DIPRA	Installation Guide for Ductile Iron Pipe.
28.	NSF61	Drinking Water System Components Health Effects.
29.	PPI Handbook	Plastic Pipe Institute Handbook of Polyethylene Pipe
30.	811 NY Dig safely	811 NY Dig Safely – Excavator Manual - Safe Excavation Practices in New York State

1.05 DESCRIPTION

A. This scope of this Section includes the requirements for the installation of buried piping, except where installation requirements for buried piping are shown or specified elsewhere in the Contract Documents. In addition:

1. The scope of this Section includes requirements for:

a. The jointing of buried piping

b. The installation of gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, and tie rods.

c. Modifications and/or adjustments to existing buried piping.

d. The installation of supports, restraints, and thrust blocks.

e. The cleaning, disinfecting, and field testing of all buried piping.

2. The extent of buried piping is shown on the Contract Drawings. The Contractor shall provide additional buried pipe as necessary and/or required to complete the Work as shown and specified. Buried pipe service, pipe diameter, coating, lining, pressure rating, joint type, and testing requirements are specified in the following section(s):

a. Section 33 06 01, Schedule for Buried Piping.

3. Where shown on the Contract Drawings, the Contractor shall provide all labor and materials for making connections between buried piping and existing lines(s) installed under other contracts, including all specials required to connect buried pipe to pipe of dissimilar material(s).

1.06 QUALITY ASSURANCE

A. Wherever the installation requirements of this Section and the referenced standards or manufacturer requirements are in conflict, the more stringent provision shall apply.

B. Ductile Iron Pipe:

1. Refer to the latest edition of the DIPRA Installation Guide for Ductile Iron Pipe and the ductile iron piping manufacturer recommendations.

a. Where requirements from the manufacturer, requirements specified by the DIRPA Installation Guide, and requirements specified herein differ, apply the most stringent requirement of the three.

C. Polyethylene Pipe:

1. Refer to the latest edition of the Plastics Pipe Institute Handbook of Polyethylene pipe and the PE piping manufacturer recommendations.

a. Where requirements from the manufacturer, requirements specified by the PPI Handbook, and requirements specified herein differ, apply the most stringent requirement of the three.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. Buried piping submittals shall be submitted under the specification section number corresponding to the buried piping material. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

a. Shop Drawings:

1) Catalog cuts and data sheets, including but not limited to:

a) Specifications for all components of the buried piping.

b) Illustrations in sufficient detail to serve as a guide for assembly and disassembly

c) A parts schedule that identifies the materials to be used for the various piping components and accessories.

d) Weights of all component parts.

e) Details on joining methods.

f) Details of pipe lining, coating, wrapping, insulation and painting.

g) Copy of details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances (pipe couplings, specials, and adapters shall be submitted for approval under Section 40 05 06, Couplings, Adapters, and Specials for Process Piping).

b. Layout and Installation Drawings:

1) Shall include plans, sections, and details showing location, elevations, and clearly marked dimensions.

2) Piece numbers which are coordinated with the tabulated pipe layout schedule shall be clearly marked.

3) The scale used shall be the greater of the following two (2) scales:

a) The scale used on the Contract Drawings that depict the process pipe for which the submittal pertains.

b) ¼-in = 1-ft - 0-in.

4) When special designs or fittings are required, the work shall be shown in large detail and the special or fitting completely described and dimensioned.

5) For HDPE Pipe, layout and installation drawings shall address locations and deflections of required fittings to prevent installation that exceeds a greater degree of bending than the manufacturer's recommended minimum bending radius for each size and class of HDPE pipe.

6) Include a north arrow.

7) Information on pipe supports, including:

a) Pipe support location.

b) Pipe support type.

c) Thrust block details.

d) All loads on the support (in either lbs. or kips.)

8) Location of pipe couplings, specials, and adapters.

9) Extent of lining, wrapping, and coatings.

c. A tabulated pipe layout schedule for each buried process pipe system. Submit a separate schedule for each pipe system and/or service. The pipe layout schedule shall include the following

information for each pipe section, fitting, and appurtenance that comprises that system:

1) Service.

2) Pipe size.

3) Working pressure.

4) Weight (in lbs.)

5) Joint type.

6) Wall thickness.

7) Piece number.

8) Laying length.

d. Calculations for the design of the support structures.

1) Design calculations shall be signed and sealed by a Professional Engineer registered in the State of New York.

2) Calculations shall include a summary of design criteria used in the design, including a description of each load case and load combination considered.

3) A tabulation shall be provided giving the column vertical and horizontal reactions for each load combination.

e. For each buried piping system that contains valves, submit a tabulated valve schedule. Submit a separate schedule for each pipe system and/or service. The valve schedule shall include the following information for each valve:

1) Valve tag number.

2) Valve size.

3) Upstream pressure (units of psig).

2. Information Submittals:

a. Certified Letters of Compliance:

1) Certificate of compliance with the requirements of the Contract Documents for pipe, fittings, couplings, sleeves, cleanouts and harnessing.

2) For welded pipe and fittings, submit a certificate from an independent testing laboratory, approved by the City, for each welder assigned to the welding of pipe, fittings, and pipeline equipment.

3) For corrugated-wall, smooth interior HDPE gravity pipe:

a) Submit a certificate of joint compliance with ASTM F477 and these specifications for each pipe size. The statement shall include date of test.

b) Submit a certificate stating that materials used for the manufacturing of the pipe and fittings for this Contract shall meet the standards per ASTM D3350

4) Linings and Coatings:

a) Manufacturer shall submit a certificates or copies thereof attesting to the fact that the applicator met the requirements of the corresponding piping specification, adherence to all standards and testing specified therein, and that the material used was as specified therein.

5) Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards specified in the corresponding piping specification section.

b. Metallic Pipe Welding Procedures and Qualifications:

1) Certificates shall be of current issue and conform to the requirements of the applicable reference standards. In addition:

a) Certificates that all welders and welding operators have been qualified in accordance with ASME Boiler and Pressure Vessel Code Section IX.

b) Certificates stating that the welding of steel and stainless steel shall conform to the requirements of ASME B31.1.

2) Copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

c. Nonmetallic Pipe Welding Procedures

1) Certificates of HDPE pipe welder experience within the previous 12 mo. shall be submitted for all technicians performing heat fusion on HDPE pipe.

2) Submit certification of qualified persons before fabricating any HDPE saddle tees.

d. For butt welded HDPE piping, submit Heat Fusion Daily Test Reports.

1) Reports shall be submitted to the Contractor and Engineer daily.

2) Reports shall also include the results of any bent strap tests performed that day.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Polyethylene Underground Warning Tape:

1. Brady Corp., Milwaukee, WI;
2. Marking Services, Inc., Milwaukee, WI;
3. Seton Identification Products, Branford, CT;
4. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Warning Tape:

1. General:
   a. Tracer tape shall be of inert, acid- and alkali-resistant polyethylene.
   b. All tape shall be suitable for direct burial.
   c. Message:
      1) Shall read as follows: "CAUTION [Potable Water, Storm, or Sanitary] PIPE BURIED BELOW"
      2) Shall be written with bold letters 2-in. high.
      3) Messages shall be printed at maximum intervals of 2 ft.
      4) Tape color shall be per the Utility Color Codes in the 811 NY Excavator Manual.
2. For Metallic Pipelines:
   a. Size:
      1) Thickness: 4 mils.
      2) Width: 6-in.

b. Tape shall:

1) Be capable of stretching to twice its original length.

3. For Non-Metallic Pipelines:

a. Size:

1) Thickness: 5 mils.

2) Width: 6-in.

b. Tape shall:

1) Have aluminum backing.

2) Have 15,000 psi tensile strength.

3) Have 140% elongation capability.

B. Polyethylene Encasement:

1. Provide polyethylene encasement for all buried ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.

2. Provide polyethylene encasement in accordance with AWWA C105.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation.

1. Immediately remove defective materials from the Site and replace with acceptable products.

B. All pipe coating injured in any way during transit or laying shall be satisfactorily repaired prior to placing the backfill.

1. Ample provision shall be made for the prompt and efficient repair of all abrasions and injuries.

C. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-

type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.

D. Certificates of welding qualifications conforming to the requirements of ASME B31.1, Section 6 and its Supplements, shall be submitted to the Engineer for approval prior to proceeding with any pipe welding.

3.02 INSTALLATION

A. General:

1. All piping shall be erected to accurate lines and grades, supported as shown, specified, or required.
    a. Slope piping uniformly between elevations shown.
2. Where temporary supports are used during construction, sufficient strength and rigidity shall be provided to prevent shifting or distortion of the pipe.
3. All Work shall be accomplished using the best methods and procedures of recognized pipe fabrication in a good and workmanlike manner in accordance with the latest edition of the applicable standards referenced in the Contract Documents, including (but not limited to):
    a. For ductile iron pipe:
        1) AWWA C105
        2) AWWA C600.
        3) AWWA M41.
    b. For thermoplastic pipe:
        1) ASTM D2321.
        2) ASTM D2774.
        3) AWWA C605.
        4) AWWA M23.
        5) AWWA M55.
4. All buried pipe, fittings, and appurtenances shall be installed in accordance with all of the following:
    a. The manufacturer's printed instructions and recommendations.
    b. The approved shop drawings.
    c. As specified in the Contract Documents.
5. Routing:
    a. Install piping in a neat manner with lines straight and parallel or at right angles to building walls or structures, unless otherwise shown on the Contract Drawings.

1) Install horizontal lines true to line and elevation.

2) Install vertical lines truly plumb in all directions.

b. Where practicable, install piping in groups and parallel to building walls or structures.

c. Clearance:

1) Clearances shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.

d. Small diameter piping and/or piping not shown on the Contract Drawings:

1) If specific locations and elevations are not shown on the Contract Drawings, install small diameter piping as specified herein, and as necessary and required to avoid obstructions.

6. Cuts:

a. Use cutting methods and machines specially designed for cutting the pipe material and approved by the manufacturer. The following cutting methods are not acceptable:

1) "Squeeze" type pipe cutters

2) Cutting torches

3) Diamond points

4) Dog chisels.

b. Pipe Lengths:

1) Full standard lengths of pipe shall be used in each pipe run in so far as possible.

2) Shorter lengths than standard shall be used only to complete a straight run of pipe, to connect to established locations of valves, equipment, bends, and the like.

3) Random lengths of pipe or cuttings from standard lengths shall not be coupled together when a full standard pipe length will fit in the pipe run.

c. Pipe shall be cut square, and not upset, undersized, or out of round, except as follows:

1) Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth.

d. Ends shall be carefully reamed and cleaned before being installed.

e. Make cuts carefully without damage to coatings or linings.

7. Excavation:

a. Trench excavation shall conform to the requirements of Section 31 23 16 - Excavation, as applicable.

b. Dewater trench before pipe installation in accordance with Section 31 23 19 - Dewatering.

1) Keep groundwater level in trench at least 24-in. below bottom of pipe before laying pipe.

2) Do not lay pipe in water.

3) Maintain dry trench conditions until jointing and backfilling are complete.

4) Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.

c. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.

d. Excavate around joints in bedding as necessary and required to complete joint connection.

8. Placing:

a. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

b. For coated pipe, care shall be exercised in laying and cradling the pipe to prevent injury to the coating.

c. Start laying pipe at lowest point and proceed towards higher elevations.

1) On steep slopes, prevent movement of pipe during installation.

d. Lay pipe so that pipe barrel bears uniformly on trench bottom.

e. Exercise care to avoid flotation when installing pipe in cast in-place concrete, and in locations with high groundwater.

f. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.

g. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.

h. Install bell and spigot pipe so that bells face the direction of laying, unless otherwise shown on the Contract Drawings.

i. Allow extra length at future connection points to be cut to fit after backfill and prior to tie-in.

j. Notify the Engineer prior to installing pipe into trench and allow time for Engineer's inspection.

k. The Contractor shall correct irregularities found during inspection.

l. Complete tie-ins within trench whenever possible to prevent overstressed connections.

9. Bedding:

a. Backfill shall conform to the requirements of Section 31 23 23 - Fill, as applicable.

b. Carefully and thoroughly compact pipe bedding with handheld pneumatic compactors.

10. Jointing:

a. Thoroughly clean all pipe, fittings, valves, specials, and accessories before jointing.

1) Remove all cuttings and foreign matter from inside of pipe and tubing.

2) Clean joining area of pipe, fittings, and appurtenances as necessary and required and as per manufacturer instructions.

a) For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.

b. Use jointing methods recommended and approved by the pipe manufacturer.

c. Transitions from One Type of Pipe to Another:

1) Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

2) Connections between Dissimilar Metals:

a) Provide dielectric couplings, insulating couplings, unions, or other approved dielectric insulating devices, at all connections to pipelines or equipment of dissimilar metals, regardless of whether devices are shown on the Contract Drawings.

11. Bends and Turns:

a. Bends shall be of 45° or 90° unless otherwise shown on the Contract Drawings.

b. Pipe Flexibility:

1) Do not bend pipe to greater degree than minimum radius recommended by the pipe manufacturer for type and grade.

2) Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.

12. Plugs:

a. Shall match the materials, linings, and coatings of the process piping, and shall have a square head.

13. Transitions:

a. Reducing fittings shall be used for all changes in pipe sizes, even when not specifically shown on the Contract Drawings.

1) Unless otherwise shown or specified, use eccentric reducing fittings.

b. Do not use bushings or nipples for buried piping.

c. Between pressure ratings:

1) Where lines of lower service rating tie into services, appurtenances, or equipment of higher service rating, the equipment, valve, or appurtenance between the two shall conform to the higher rating.

14. Restraints, Supports, and Thrust Blocks:

a. Provide concrete and metal cradles, collars, kickers, and blocks as shown on the Contract Drawings or as necessary and/or required to provide thrust restraint.

15. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:

a. At the end of each day of Work or other interruption of pipe installation, the Contractor shall provide temporary blind flanges, plugs, caps, or bulkheads as necessary and required.

1) Plug all bells at dead ends, tees, and crosses.

2) Cap all spigot and plain ends.

b. To perform the testing of buried piping as specified herein, or as per the sequence of work specified in the Contract Documents, the Contractor shall provide temporary blind flanges, line stops, plugs, and bulkheads suitable for and capable of withstanding the services and pressures for which they are intended.

1) Refer to Section 33 06 01, Schedule for Buried Piping, for service and test pressures.

2) Temporary blind flanges, line stops, plugs, and bulkhead shall be compatible with and shall not damage the piping materials, coatings, and linings specified in Section 33 06 01, Schedule for Buried Piping.

c. The Contractor shall uninstall all temporary blind flanges, plugs, caps, and when they are no longer needed for the Work.

B. Ductile Iron Pipe:

1. Cutting:

a. Where field cutting of ductile iron pipe is permitted by the Engineer, ductile iron pipe shall be cut only by means of abrasive saws, hack saws, wheel type cutters or milling type cutters.

2. End Connections:

a. Mechanical Joint:

1) Ensure that cut ends are tapered and sharp edges are filed off smooth. Thoroughly clean the plain end (spigot) and the socket of the pipe or fitting.

2) Brush the socket, spigot end, gasket, and adjacent areas immediately before making joint with soapy water in accordance with AWWA C111.

3) Slip the gland and gasket over the spigot with the small side of the gasket facing the socket and the lip side of the gland facing the socket.

4) Insert the spigot into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.

5) Slide the gland towards the socket and center it around the pipe with the gland lip against the gasket.

6) Insert bolts and tighten nuts by hand.

7) With an ordinary ratchet wrench, tighten bolts evenly and alternately around. The pattern for tightening bolts shall be as per the manufacturer's recommendations. The bolt torque for mechanical joints shall be as per the DIPRA Installation Guide.

8) Do not deflect mechanical joint pipe after installation.

b. Push-On Joint:

1) Ensure that the spigot (plain) end is beveled as per the manufacturer’s recommendations and that sharp edges are filed off smooth.

a) Use a heavy file or grinder to bevel the plain end.

b) Do not use a saw blade to bevel the plain end.

2) Thoroughly clean the groove and the bell socket of the pipe or fitting. Also clean the plain end of the mating pipe or fitting.

3) Except for pipe lined or coated, use a wire brush to clean the exterior surface of the spigot and the interior surface of the bell.

a) Use a method for cleaning coated or lined portions of the pipe recommended by the coating or lining manufacturer.

4) Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.

a) Use a rubber gasket recommended by the pipe manufacturer.

(1) Do not use gaskets that have been scored or otherwise damaged.

b) Wipe clean rubber gaskets and flex gaskets until resilient. follow the manufacturer instructions for gasket resiliency when assembling joints in cold weather.

c) As per the DIPRA Installation Guide, make at least one (1) small loop and then insert the gasket into the socket.

(1) For pipe sizes larger than 20-in. nominal diameter, it may be necessary to make two loops in the gasket opposite each other.

(2) Make sure the gasket faces the correct direction as per the manufacturer's instructions and that it is properly seated.

5) Apply lubricant as per the manufacturer recommendations to the surface of the gasket that will come in contact with the entering spigot. Also apply lubricant to the outside of the entering spigot.

(1) As per the DIPRA Installation Guide, do not apply lubricant to the bell socket or the

surface of the gasket in contact with the bell socket.

6) Push the spigot end into the bell socket of the mating pipe or fitting, ensuring the joint remains straight.

a) Pause insertion when the spigot end just makes contact with the rubber gasket.

b) After the gasket is compressed and before the pipe is inserted completely, carefully check the gasket for proper position around the full circumference of joint.

c) Final assembly shall be made by inserting the spigot end of the entering pipe past the gasket until it makes contact with the base of the bell.

7) Deflect push-on joint pipe only after the joint is assembled and not exceeding the deflection shown on the Contract Drawings and the maximum deflection specified in the DIPRA Installation Guide for the nominal diameter of pipe in question.

c. Grooved / Shouldered End Joints:

1) Grooved and shouldered end joints and their installation shall conform to the requirements of AWWA C606.

2) Thoroughly clean the joint ends to remove foreign matter. Except for coated pipe, use a wire brush to clean the exterior surface of the joint ends.

a) Use a method for cleaning the coated portion of the pipe recommended by the coating manufacturer.

3) Remove the bolts from the coupling.

4) Apply lubricant to the rubber gasket or inside of the coupling housing and joint ends as per the manufacturer recommendations.

5) Position and install the gasket over the gap between the joint ends.

6) Install the coupling housing around the gasket and over the grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand.

7) Tighten the bolts uniformly and according to the manufacturer's instructions.

d. Flanged Connections:

1) All flange faces shall be in perfect alignment with the holes straddling the vertical center line of the piping.

2) Properly center the gasket. Use full-face gaskets for flat-face flanges.

3) Gaskets shall be suitable for the service conditions referenced in Section 33 06 01, Schedule for Buried Piping.

4) The gasket thickness shall be as recommended by the pipe manufacturer, with the exception that:

5) The minimum gasket thickness for raised face flanges shall be ⅛-in.

6) Bolts shall be of sufficient length so that when fully tightened, a minimum of two full threads shall extend beyond the nut.

7) Bolts shall be well lubricated over the entire thread length with a heavy graphite and oil mixture prior to the tightening operation.

8) Bolts shall be tightened with proper wrenches, care being taken to secure uniform pressure on the bolts and gasket and to avoid over stressing of the bolts, dishing of the flanges and compression of the gasket beyond its proper limits.

a) Commercial grade carbon steel bolts, ASTM A307, Grade B shall be tightened to obtain approximately 15,000 psi stress based on the root area of the thread.

b) Alloy steel bolts, ASTM A193, Grade B7 shall be tightened to obtain a stress of 45,000 psi.

c) The pattern for tightening bolts shall be as per the manufacturer's recommendations.

3. Support:

a. Ductile iron below floors that is not to be encased in concrete:

1) Where ductile iron pipe shall be buried below floor structures, the pipe shall be supported by concrete encased adjustable clevis hangers anchored to the floor by means of bearing plates.

a) Supports shall conform to the requirements of Section 40 05 07, Hangers and Supports for Process Piping.

b) Hangers shall be spaced not more than 5 ft apart.

C. PVC Pipe Installation

1. End Connections:

a. Solvent-Welded Joints:

1) Make all solvent-welded PVC joints in accordance with ASTM D2855 and the solvent manufacturer's approved instructions.

2) Use primers and solvent cements meeting the requirements of ASTM F656 and ASTM D2564, respectively.

3) Do not make solvent cement joints if temperature is below 40°F.

4) Do not make solvent cement welded joints in wet conditions.

5) The following procedure shall be followed to ensure proper gluing of PVC pipe.

a) Ensure the end of the pipe is beveled.

b) Apply primer to the female end.

c) Apply primer to the male end.

d) Reapply primer to the female end; the primer must not dry.

e) Apply glue to the male end using an appropriately sized brush.

f) Apply glue with the brush to the female end.

g) Reapply glue to the male end.

h) Join the male and female ends with a quarter turn twist and hold for 30 sec.

6) After joint assembly, wipe excess cement from the pipe. A properly made joint will show a bead around the entire circumference. Any gaps in this bead indicate a defective joint, and the Contractor shall remake such joints at no additional cost to the City.

D. HDPE Pipe Installation:

1. End Connections:

a. Butt Welded Joints:

1) Butt weld via a heat fusion process in accordance with manufacturer's recommendation for butt fusion methods.

a) Personnel operating fusion equipment shall be certified by the HDPE pipe manufacturer.

2) Branch saddle fusions shall also be joined in accordance with manufacturer's recommendations and procedures.

a) Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.

b. Flanged Connections:

1) Connect slip-on Type 316 stainless steel backup flanges with Type 316 stainless steel nuts and bolts.

2) Butt fuse fabricated flange adapters to pipe.

3) Observe following precautions in connection of flange joints.

a) Align flanges or flange/valve connections to provide tight seal.

(1) Require nitrile-butadiene gaskets if needed to achieve seal.

(2) Integral flange adapters and gaskets are required for flange/valve connections.

b) Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations.

(1) Bolts shall be lubricated in accordance with manufacturer's recommendations.

c) Tighten flange bolts in sequence and accordance with manufacturer's recommendations. Do not over-torque bolts.

4) Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendation.

5) Install electrofusion couplers, where used, in accordance with manufacturer's specifications.

2. Fittings:

a. Saddle tees 8-in. and smaller may be field fabricated. Saddle tees larger than 8-in. must be factory manufactured.

3. Placing:

a. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion, but shall not exceed 400 ft.

b. Cap pipe sections longer than single joining (usually 50 ft) on both ends during placement, except during fusing operations.

c. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.

d. Install reducers adjacent to laterals and tees.

e. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.

f. Pipe shall be snaked in trench to allow a minimum of 12-in./100 ft for thermal contraction and expansion.

E. Corrugated-wall, smooth-interior HDPE Gravity Pipe:

1. General:

a. Corrugated-wall, smooth-interior HDPE gravity pipe shall be installed by open trench construction – directional bore installation shall not be permitted.

b. Installation shall conform to the requirements of ASTM D2321.

2. Cutting:

a. Field cuts shall be made with a handsaw or power pipe cutoff saw.

b. For pipes of annular corrugations, square cut only through a corrugation valley, never through a corrugation sidewall.

3. End Connections:

a. Bell and Spigot Joints:

1) Joint shall be soil-tight.

2) Pipe shall be joined meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306, as applicable.

3) Gaskets:

a) Shall meet the requirements of ASTM F477.

b) Shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris.

4) A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

4. Placing:

a. Pipe sections shall be lowered into the trench without damage to the pipe or pipe ends where couplings are to be made.

b. During handling, placement and joining, bell and spigot joints, other gasketed joints, and gaskets shall be free of mud, grit and other foreign material in order to enable effective joining and sealing.

c. When the assembling of pipes is interrupted, closures shall be placed at ends of pipes to prevent the introduction of dirt, water, animals and other foreign matter.

d. Lubricate joints in accordance with manufacturer's instructions for lubricant type and manner of application to the gasket, and/or the surface in contact with the gasket.

1) Each gasketed joint shall be inspected for cleanliness and proper lubrication before mating.

e. Align joint and drive the spigot end of one pipe its proper distance into the receiving bell of an adjoining pipe with a bar and block or mechanical equipment.

1) Prior to the use of such apparatus and method, demonstrate to the Engineer for approval the effectiveness and practicability of the proposed method of drawing the joints home.

2) The selected method shall avoid sudden thrusts of force and the gasket shall always remain in its intended groove.

5. Connection of corrugated-wall, smooth-interior HDPE gravity pipe to precast concrete manholes and other structures:

a. Soil-Tight Joints:

1) Grout void space between the pipe and structure with non-shrink grout.

b. Watertight Joints:

1) Provide a flexible boot fitting in accordance with ASTM F2510 and manufacturer recommendations.

6. Connection of corrugated-wall, smooth-interior HDPE gravity pipe to plastic drainage structures:

a. Provide adapter fitting in accordance with ASTM D3212, ASTM F477 and manufacturer recommendations.

F. Separation of Sewers and Potable Water Piping:

1. Requirements for the separation of sewers and potable water piping apply to all buried piping installation, regardless of piping materials.

2. In the event that the requirements specified herein differ from separations shown on the Contract Drawings and/or differ from separations required by Authorities Having Jurisdiction, the more stringent (i.e., greater separation distance) shall apply.

3. The Contractor shall install all buried potable water piping and sewers with the following separations:

a. For water mains installed parallel to sewers:

1) Where the depth to the bottom of the sewer cradle is less than 10 ft, the clearance between the outside of the water main and the centerline of the existing sewer should be not less than 6 ft plus one-half the sewer diameter.

2) Where the depth to the bottom of the sewer cradle is 10 ft or more, the clearance between the outside of the water main and the centerline of the existing sewer shall be increased 1 ft for each additional 5 ft of depth over 10 ft, or portion thereof.

b. For water mains crossing sewers:

1) Wherever the clearance between the top of an existing sewer and the bottom of the proposed water main, at their crossing, is less than 1 ft, the water main is to be supported by a truss arrangement and the clearance space is to be filled with layers of compressible material to avoid excessive bearing pressure on the sewer pipe.

a) In no case, however, should this clearance be less than 6 in.

3.03 FIELD TESTING / QUALITY CONTROL

A. Test all buried piping in accordance with the requirements of Section 33 05 05.30 - Leakage Testing for Buried Piping.

B. Visual Inspection:

1. Pipes 30-in. and greater in diameter shall be visually tested by entering and recording direct measurements.

2. For smaller pipes with runs no longer than 100 ft, visually inspect from the pipe end (lamping).

C. Videotape Inspection:

1. All installed buried pipes shall be visually inspected by video, or closed circuit television (CCTV).

2. Video inspection shall be submitted to the Engineer for review and approval.

3. The Contractor shall make installation modifications requested by the Engineer based on final visual and CCTV inspection.

D. Field Testing of HDPE Pipe:

1. The first butt fusion weld of each day’s production welding and for each separate operator shall be tested by bent strap test method.

2. No production welds shall be performed until successful completion of bent strap test.

3. Each field fusion shall be recorded by such equipment and this information shall be made compiled into daily log reports.

E. Field Testing of corrugated-wall, smooth-interior HDPE pipe:

1. Deflection Testing

a. Measure for allowable deflection not less than 30 d following completion of installation.

b. Allowable deflection shall be no greater than 7.5%.

1) The base inside diameter used shall be calculated using the equation:

$$d_{i,base} = d_{i,design} - \sqrt{(\Delta d_{tolerance})^2 + (\Delta d_{out\ of\ round})^2}$$

where: $d_{i,base}$ = Base inside diameter
$d_{i,design}$ = Design inside diameter
$\Delta d_{tolerance} = 1.0\%$, as per ASTM F2306
$\Delta d_{out\ of\ round} = 3\%$

c. Mandrel Testing:

1) Pipes less than 30-in. diameter may be tested by pulling a mandrel device from manhole to manhole, pre-set with the minimum allowable inside diameter specified herein.

2. Leakage Testing:

a. The Contractor shall perform infiltration or exfiltration testing in accordance with ASTM F2487.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required, to test all buried piping complete and operational.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 33 05 05 – Buried Piping Installation.

B. Section 33 06 01 – Schedule for Buried Piping.

1.04 REFERENCES

A. Definitions:

1.	Buried Piping:	Includes all piping beginning at the outside face of a structures or foundation and extending away from structures. Buried piping includes piping beneath structures or foundations.
2.	Exposed Piping:	Includes all piping beginning at the outside face of a structures or foundation and extending inside. Exposed piping also includes all piping embedded in concrete, as well as all piping that is permanently or intermittently submerged and/or installed in a subaqueous environment.

B. Reference Standards:

1.	ACI 350.1-10	Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary.
2.	AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances.

3. Code of the Town of Mount Pleasant, New York.

1.05 DESCRIPTION

A. This scope of this Section includes the requirements for the testing of buried piping, except where testing requirements for buried piping are shown or specified elsewhere in the Contract Documents. In addition:

1. The scope of this Section also includes the requirements for testing buried gravity sewers and concrete structures.

B. All buried pipelines, gravity sewers, and structures for which testing requirements are specified in this Section shall be watertight or airtight, including, but not limited to:

1. All buried piping and appurtenances installed under Section 33 05 05, Buried Piping Installation.

2. All buried piping, structures, and appurtenances installed under other Sections, but that specify testing under this Section.

C. Piping and structures which fail leakage tests shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Engineer. These repaired piping and structures shall then be retested at the Contractor's expense until leakage test results meet the requirements specified herein.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. Buried piping testing submittals shall be submitted under the specification section number corresponding to the buried piping material. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

a. Testing Procedures:

1) Submit proposed testing procedures, methods, apparatus, and sequencing.

2) Testing procedures shall be submitted for approval at least 30 consecutive calendar days (ccd) prior to the test.

b. Testing Report:

1) Prior to placing the piping system or structure in service, submit for review and approval a detailed bound report summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based.

2. Informational Submittals:

a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.

b. Results of each specified field quality control test.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. The Contractor shall provide all labor, equipment, air, water and materials, including meters, gauges, blower, pumps, compressors, hoses, fuel, water, bulkheads, temporary bracing and restraints, temporary weirs, valves, plugs, and accessory equipment necessary and required to complete the testing as specified herein.

B. Testing medium:

1. The Contractor shall provide all air or gasses necessary or required for testing.

2. Unless otherwise specified, the existing facility shall provide all water (or process fluid) required for testing.

a. The Contractor shall provide all means to convey the fluid into the piping being tested.

3. Refer to the Contract Drawings for availability of water to be used for testing.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Notification:

1. Provide the Engineer with written notice at least 14 ccd prior to the date of testing.

a. No tests shall be conducted without an approved written procedure.

b. The Engineer shall respond in writing to the Contractor within 7 ccd of receiving the written notification.

B. All leakage tests shall be conducted in the presence of the Engineer.

1. All leakage tests shall be conducted in the presence of local authorities having jurisdiction, if required.

C. Remove or protect devices and appurtenances that could be damaged by testing.

D. Backfilling of buried or concealed pipelines:

1. Completely backfill all harnessed sections of buried or concealed piping before such sections are tested.

2. Non-harnessed sections of buried piping shall be tested before backfilling.

3.02 IMPLEMENTATION

A. General:

1. Perform leakage testing for all buried piping in accordance with the requirements of Section 33 06 01, Schedule for Buried Piping, except piping explicitly shown or specified as exempted from testing. For pipelines not listed in Section 33 06 01:

a. Test all buried pipelines using a hydrostatic test.

b. Test all gravity sewers and drain lines using either an infiltration or exfiltration test based on the groundwater elevation.

c. Test compressed air and gas pipelines using a hydrostatic test with compressed air.

d. Test all other pipelines not listed in Section 33 06 01, including outfall sewers, via a hydrostatic test with clean water.

e. Test vents and drains in plumbing systems and plumbing soil pipe lines in accordance with the Town of Mount Pleasant Code, unless otherwise specified. Unless specified otherwise, test all vents and drains on process piping as for plumbing systems.

2. Operation of Existing Facilities:

a. Conduct all tests in a manner to minimize interference with operations of existing facilities or Other Contractors working on the Site.

3. Testing of pipelines and conduit with non-circular cross-sections:

a. Leakage in pipelines of other than circular section shall not exceed an amount based on a circular section having an equivalent inner perimeter.

B. Hydrostatic Testing

1. Application:

a. Buried pipelines.

2. Test Procedure:

a. Maintain the testing medium at the specified pressure for a period of 4 hrs.

1) Unless otherwise specified, the testing medium shall be clean water.

2) Do not use air for hydrostatic testing of pipelines intended for liquid service – use compressed air (or gas) only for the hydrostatic testing of air (or gas) pipelines.

b. Test the piping as a whole or in sections.

1) The Contractor shall use valves or install temporary bulkheads at the ends of each section.

2) Remove temporary bulkheads at the conclusion of the hydrostatic testing.

c. Apply the specified hydrostatic test pressure to the piping through a tap in the pipe by means of a pump, compressor, or other approved method.

3. Test Pressures:

a. Test the pipeline at the pressure specified in Section 33 06 01, Schedule for Buried Piping.

b. If no test pressure is specified for a hydrostatic test, submit a test pressure of 1.5 times the maximum possible operating pressure of the pipeline, for approval by the Engineer

4. Leakage:

a. The allowable leakage shall not exceed the testing allowance given by the following formula from AWWA Standard C600:

$$L = \frac{S \cdot D \cdot \sqrt{P}}{148{,}000}$$

Where: L = testing allowance (makeup water) (gph).
S = length of pipe tested (ft).
D = nominal diameter of the pipe, (in.).
P = average test pressure during the hydrostatic test (psig).

5. Repair:

a. Replace broken pipe or joint assemblies found to leak.

b. When leakage occurs in excess of the specified amount, locate and repair defective valves, pipe, cleanouts or joints.

c. If defective portions cannot be located, remove and reconstruct as much of the original work as necessary to obtain piping that meets the leakage requirements specified herein and retest, all at no additional cost to the DEP.

C. Hydrostatic Testing of Valves

1. Test Procedure:

a. Prior to the application of the test pressure, operate the valve(s) through the number of complete cycles of closing and opening recommended by the manufacturer.

b. Next, apply the test pressure to one side of the valve (i.e., the first side).

1) The valve shall be in the closed position.

2) Introduce the liquid testing medium to the first side only and apply the test pressure.

a) The other side of the valve(s) (i.e., the second side) shall be dry and unpressurized (0 psig).

3) Maintain the testing medium at the specified pressure for a period of 4 hrs.

c. Then, reverse the side to which the test pressure is applied.

1) The valve shall still be in the closed position.

2) Now apply the test medium and pressure to the other side of each valve (i.e., the second side).

3) The side tested first (i.e., the first side) shall now be unpressurized (0 psig).

4) Maintain the testing medium at the specified pressure again for a minimum period of 4 hrs.

d. Hydrostatic testing of valve(s) may be concurrent with hydrostatic testing of pipeline section(s) to the extent permissible by the testing requirements specified herein.

e. The Contractor shall be responsible for draining and disposing of the test medium in accordance with the requirements of the Contract Documents, as necessary and required to test both sides of each valve in this manner.

2. Test Pressure:

a. Hydrostatic test each valve such that the differential pressure across the valve at the same test pressure specified for the pipe in which the valve is installed.

3. Leakage:

a. Stop all external and internal leakage through the valves.

b. No leakage across the valve shall be acceptable.

4. Movement:

a. Stop all valve movement or structural distress.

b. No movement of the valve is acceptable.

D. Infiltration Test

1. Application:

a. Gravity sewers where the groundwater level is above the crown of the sewer.

2. Test Procedure:

a. Do not start testing until normal infiltration conditions are established in the work to be tested.

1) Inspect the gravity sewer visually for infiltration.

2) If necessary, pump the sewers dry and make sure the groundwater level is above the crown of the sewer.

a) The Contractor shall dispose of water pumped from the sewer in accordance with the requirements of the Contract Documents.

3) Inspect the sewer on the inside and seal all visible leaks completely.

4) Conduct the infiltration test only after the sewer has been pumped out.

b. Measure the infiltrated flow of water by means of a weir set up in the invert of the sewer at a known distance from a temporary bulkhead or other limiting point of infiltration.

1) The leakage rate shall be defined as the amount of groundwater passing over the weir.

c. Carry on tests for a minimum of 8 hrs. with readings at 60 min intervals.

3. Leakage:

a. In computing the length of sewer contributing to infiltration, include the length of house connections tested, if any, in the total length.

b. The leakage infiltration for any section of the sewer system shall not exceed 100 gal/in. diameter/mi length/24 hrs.

4. Repair:

a. When the measured leakage exceeds the specified amount, locate and repair defective manholes, pipe, and/or pipe joints.

1) If the defective portions cannot be located, remove and reconstruct as much of the original work as necessary and required to obtain a sewer within the allowable infiltration limits upon such retesting as necessary.

b. Regardless of the amount of infiltration or leakage measured, repair and seal in an approved manner all visible or detectable leaks in the sewers, manholes, structures, and other appurtenances.

E. Exfiltration Test

1. Application:

a. Gravity sewers where the groundwater level is below the crown of the sewer.

2. Test Procedure:

a. Construct a bulkhead in the sewer at the manhole at the lower end of the section under test.

b. Fill the section being tested with water until the level of water is 4 ft above the crown of the sewer in the manhole at the upper end of the test section.

1) For concrete sewers, allow the water to remain in the piping for at least 12 hr before conducting the tests.

c. Leakage will be the measured amount of water added to maintain the water at that level once the test commences.

d. Carry on tests for a minimum of 8 hr with readings at 60 min intervals.

3. Leakage:

a. In computing the length of sewer contributing to leakage, include the length of house connections tested, if any, in the total length.

1) The leakage exfiltration for any section of the sewer system shall not exceed 100 gal/in. diameter/mi length/24 hrs.

4. Repair:

a. When the measured leakage exceeds the specified amount, locate and repair defective manholes, pipe, and/or pipe joints.

1) If the defective portions cannot be located, remove and reconstruct as much of the original work as necessary and required to obtain a sewer within the allowable infiltration limits upon such retesting as necessary.

b. Regardless of the amount of infiltration or leakage measured, repair and seal in an approved manner all visible or detectable leaks in the sewers, manholes, structures, and other appurtenances.

F. Tests for Concrete Structures

1. Application:

a. Wet wells, tanks, channels, containment areas, and other water retaining structures.

2. Test Procedure:

a. Test according to the requirements of ACI 350.1 and as specified herein.

b. The Contractor shall supply all materials and labor needed to conduct the test as specified herein.

c. Prior to start of leakage testing, the following requirements shall be met:

1) All elements of the structure which resist any portion of the retained liquid pressure shall be in place and at specified strength levels. All concrete shall be fully cured.

2) Structure walls shall not be backfilled prior to leakage testing.

3) All valves, gates, blind flanges, and other non-concrete items which control the flow or otherwise retain the liquid contents of the structure, shall be checked for water-tightness. If not water-tight, means shall be taken to assure water-tightness during the period of the leakage test.

4) The portions of the structure to be tested shall be cleaned of all construction debris, standing water, soil, foreign materials and any other material which interferes with the exposed concrete surfaces of the structure.

5) Contractor shall repair defective concrete.

6) The Contractor shall notify the Engineer a minimum of 24 hrs prior to start of filling of structure for leakage testing.

7) Leakage testing shall not start until the structure is inspected by the Engineer.

d. Filling the Structure with Water:

1) The portion of the structure to be tested shall be filled at a rate not to exceed 2 ft/hr.

2) The structure shall be filled to the normal operating depth of the structure as indicated on the Contract Drawings.

a) Where no operating depth is indicated or where operating depth is controlled by flowing over a weir, the structure shall be filled to a depth 6 in. below the weir or top of wall elevation, whichever is lower.

3) Water in the structure shall be maintained at the specified test elevation for a minimum of 3 d prior to the start of the leakage test.

e. After water has been brought to the test elevation, the exposed elements of the structure shall be inspected for leakage.

1) All locations which exhibit any amount of leakage flow shall be repaired prior to the start of leakage testing.

f. Unless otherwise specified, the leakage test duration shall be based on ACI 350.1 or last 3 d, whichever is greater.

g. Measure for leakage at the test locations:

1) Structure cells which are less than 1000 ft^2 in area: measurements of water shall be taken at two (2) locations which are located approximately 180° apart.

2) Structure cells which are greater than 1000 ft^2 in area: measurements of water level shall be taken at four (4) locations which are located approximately 90° apart.

3) Each test location shall be marked and given a reference number.

a) A reference point shall be marked on the face of the wall above the test water surface in a manner which will prevent its movement or deterioration during the period of the test.

4) Test locations must be approved by the Engineer.

h. Account for evaporation and precipitation while measuring for leakage:

1) In open structures, a clear plastic calibrated open-top container not less than 18 in. in diameter and depth shall be partially filled, floated in the tank, and held in position near each measurement location.

2) The container shall be located so as not to be shaded by tank walls and away from any items passing over it such as beams or pipes.

i. Leakage tests shall not be started when periods of severe weather conditions or major changes in average daily temperature are predicted.

j. The following measurements shall be recorded at each test location at the start of the test period and at 24-hr intervals thereafter:

1) Distance from reference point to test water surface.

2) Depth of water in the floating container.

3) Temperature of the test water at 18 inches below water surface.

4) Temperature of the water in the evaporation-precipitation container at mid-depth.

3. Leakage:

a. The change in water surface elevation at each test location shall be averaged.

b. The total change in test water surface elevation shall then be adjusted by the average change in water surface elevation in the evaporation-precipitation containers.

c. Where averaged water temperature measurements vary by more than 3°F from start to completion of the test period, adjustment in tank volume shall be determined by change of water density resulting from the change in the average water temperature.

d. Leakage Allowance

1) For unlined concrete structures: the maximum allowable leakage rate shall be 0.075%of the volume per 24-hr period.

2) For concrete structures with walls lined by a waterproof material, the maximum allowable leakage rate shall be 0.050% of the volume per 24-hr period.

4. Retesting and Repair:

a. The leakage test shall be considered as failed if the specified leakage allowance is exceeded or if any leakage is observed.

b. If the test becomes unreliable due to excessive precipitation or other external factors, it shall be restarted.

c. If a leakage test fails, it may be retested immediately without repairs if approved by the Engineer.

d. If subsequent leakage tests fail, the Contractor shall repair all probable areas of leakage and the leakage test shall be repeated.

1) The structure shall be retested until it meets the specified leakage criteria.

2) Repairs shall be made to the probable leakage areas before each retest.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install, and test all Corrugated-Wall Smooth-interior HDPE gravity pipe, complete and operational.

B. The following index of this Section is presented for convenience:

C. Schedules:

1. Refer to the following Section(s) for additional information on the piping that is to be constructed using the pipe materials and methods specified herein:

   a. Section 33 06 01, Schedule for Buried Piping.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the

applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 33 05 05 – Buried Piping Installation.

B. Section 33 06 01 – Schedule for Buried Piping.

1.04 REFERENCES

A. Abbreviations and Acronyms:

1.	ESCr	Environmental Stress Cracking.
2.	HDPE	High-density polyethylene.
3.	NCLS	Notched Constant Ligament Stress.

B. Reference Standards:

1.	ASTM F2306	12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
2.	ASTM F2648	2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications
3.	ASTM D2321	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
4.	ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
5.	AASHTO Section 30	Construction Standard for Thermoplastic Pipe
6.	AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
7.	AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
8.	Plastics Pipe Institute - Corrugated Polyethylene Pipe Design Manual & Installation Guide	

1.05 DESCRIPTION

A. This Section includes requirements for providing HDPE process pipe and accessories in accordance with applicable standards and regulations. In addition:

1. The extent of corrugated-wall, smooth-interior HDPE gravity pipe is shown on the Contract Drawings. Corrugated-wall, smooth-interior HDPE gravity pipe service, pipe diameter, pressure rating, joint type, and testing requirements are specified in the following section(s):

   a. Section 33 06 01, Schedule for Buried Piping.

2. Corrugated-wall, smooth-interior HDPE gravity pipe, fittings, appurtenances, and specials shall be furnished and installed complete with all necessary jointing materials, wall castings, wall sleeves, specials, adapters, and other appurtenances as shown on the Contract Drawings, as specified herein, and/or as necessary and required for a complete installation.

3. Where shown on the Contract Drawings, the Contractor shall provide all labor and materials for making connections between corrugated-wall, smooth-interior HDPE gravity pipe an existing line(s) installed under other contracts, including all specials required to connect corrugated-wall, smooth-interior HDPE gravity pipe to pipe of dissimilar materials.

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturer:

1. The manufacturer shall have a minimum of five (5) years of experience in the design and fabrication of corrugated-wall, smooth-interior HDPE gravity pipe, fittings, appurtenances, and specials of similar size, capacity, and type to those shown on the Contract Drawings and specified in the Contract Documents, and shall show evidence of at least five (5) substantially similar installations in satisfactory operation.

B. Supply and Compatibility:

1. All corrugated-wall, smooth-interior HDPE gravity pipe and fittings included in this section shall be provided by the Contractor through a single, qualified corrugated-wall, smooth-interior HDPE gravity pipe manufacturer.

2. The pipe and fittings shall be designed, fabricated, and installed in accordance with the latest standards specified herein.

3. The manufacturer shall verify compatibility between the corrugated-wall, smooth-interior HDPE gravity pipe, fittings, appurtenances, specials, and other Work.

C. Regulatory Requirements

1. Corrugated-wall, smooth-interior HDPE gravity pipe and fittings shall conform to the requirements of the latest edition of the "Corrugated Polyethylene Pipe Design Manual & Installation Guide" by the Plastics Pipe Institute.

1.07 SUBMITTALS

A. Submittals for all corrugated-wall, smooth-interior HDPE gravity pipe shall comply with the requirements of Section 33 05 05, Buried Piping Installation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. Pipe walls and corrugations, gaskets, pipe ends, couplers or other joints, and accessories shall be visually inspected for damage such as cuts, gouges, delamination, bulges, flat areas and ovality that may have occurred during shipment.

a. Immediately remove damaged materials from Site and replace with acceptable material.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. The Contractor shall unload and handle corrugated-wall, smooth-interior HDPE gravity pipe as follows:

a. Refer to the manufacturer unloading and handling instructions.

b. Pipes 18 in. or less in diameter may be hand lifted and placed.

c. Pipe larger than 18-in. diameter shall require mechanical equipment; a minimum of two (2) lifting slings of fabric or plastic, located at third points along the length, shall be required.

1) Metal chains and cables are not permitted.

2) Equipment such as loading booms or forklifts are not permitted.

d. Dropping and/or rolling of pipes during unloading and handling is not permitted.

2. The Contractor shall stockpile corrugated-wall, smooth-interior HDPE gravity pipe as follows:

a. Palletized pipe shall remain on pallets for jobsite storage. Non-palletized pipe shall be stockpiled for temporary storage in a flat debris-free area clear of construction traffic.

1) Do not remove tie-down straps or bands until the pipes have been secured.

b. Pipes shall be stockpiled on level ground and restricted to a stack height no greater than 6 ft.

c. To prevent rolling, blocking shall be provided at approximately third points along the length.

d. The removal of any one pipe shall not cause shifting or rolling of any of the remaining pipes.

e. The pipe shall be supported along its length, avoiding concentrated loads along bell ends.

f. Any protective covering of gaskets shall remain until the pipe is ready for installation.

1) Exposed gaskets shall be protected from dust and exposure to sunlight.

g. Couplers and fittings shall be stored flat to prevent distortion and damage.

3. Rotation of Pipe:

a. In either extreme heat and/or above temperatures recommended by the manufacturer, The Contractor shall rotate pipes during storage to eliminate deflection of ovality or shape of pipes.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Corrugated-wall, smooth-interior HDPE gravity pipe and fittings:

1. Advanced Drainage Systems, Inc., Hilliard, OH;

2. JM Eagle Co., Los Angeles, CA;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General:

1. Pipe shall have a smooth interior and annular exterior corrugations.

2. Pipe 4-in. through 10-in. pipe shall be in accordance with AASHTO M252 Type S and ASTM F2648.

3. Pipe 12-in. through 60-in. pipe shall be in accordance with AASHTO M294 Type S, ASTM F2306 and ASTM F2648.

4. Nominal pipe size, manufacturer's name, date code and applicable standards shall be marked on the pipe exterior.

5. Manning's roughness coefficients (n) value for use in design shall be 0.012.

B. Materials and Construction:

1. Material for pipe and fitting production shall be an engineered compound of virgin and recycled high density polyethylene.

2. Material shall conform with the minimum requirements of ASTM D3350, except that carbon black content should not exceed 4%.

a. For pipe 4-in. through 10-in. diameters pipe: cell classification shall be 424420C (ESCr Test Condition B),

b. For 12-in. through 60-in. diameters: cell classification shall be 435420C (ESCr Test Condition B).

3. The 12- through 60-inch virgin and recycled pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306 respectively.

C. Corrugated-wall, smooth-interior HDPE Pipe:

1. Pipe shall have the dimensions listed in Table 33 05 33.13-1, below:

TABLE 33 05 33.13-1
CORRUGATED-WALL, SMOOTH-INTERIOR HDPE GRAVITY PIPE
DIMENSIONS

Inner Diameter (nominal) (in.)	Outer Diameter* (in.)
4	4.8
6	6.9
8	9.1
10	11.4
12	14.5
15	18
18	22
24	28
30	36
36	42

42	48
48	54
54	61
60	67

2. Pipe outer diameter values in Table 33 05 33.13-1, above, are provided for reference purposes only – the table values for 12-in. through 60-in. shall be ± 1 in.

D. Fittings:

1. Fittings shall be in accordance with AASHTO M252, AASHTO M294, or ASTM F2306, as applicable.

2. Pipe ends shall be bell and spigot.

a. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

3. Watertight fittings shall provide a joint that meets the watertight requirements of ASTM D3212.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Damaged pipe will be rejected and shall be replaced at the Contractor's expense.

3.02 INSTALLATION

A. Install corrugated-wall, smooth-interior HDPE gravity pipe, fittings, and specials in accordance with the requirements of the following Section(s):

1. Section 33 05 05, Buried Piping Installation.

B. Pipe Fill Materials

a. The embedment material shall be a coarse-grained soil such as gravel or sand, or a coarse gained soil containing fines, such as a silty or clayey sand. The particle size should not exceed one-half inch for 2 to 4-inch pipe, three-quarter inch for 6 to 8-inch pipe and

one inch for all other sizes. Where the embedment is angular, crushed stone may be placed around the pipe by dumping and slicing with a shovel. Where the embedment is naturally occurring gravels, sands and mixtures with fines, the embedment should be placed in lifts, not exceeding 6 inches in thickness, and then tamped. Compact to at least 95 percent Standard Proctor density as defined in ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort, (12 400 ft-lbf/ft3 (600 kN-m/m3)).

b. Primary initial backfill shall be placed and compacted in lifts evenly placed on each side of the pipe. The lifts should not be greater than 8 inches. The primary initial back fill should extend up to at least three-quarters of the pipe diameter to perform its function of pipe side support. Compact to at least 95 percent Standard Proctor density as defined in ASTM D698, Standard Test Methods for Laboratory Compaction

c. Secondary initial backfill shall extend to 6 inches above pipe up to 24 inches and to 12 inches for larger pipe. Compact to at least 95 percent Standard Proctor density as defined in ASTM D698, Standard Test Methods for Laboratory Compaction

d. The final backfill may consist of the excavated material, provided it is free from unsuitable matter such as large lumps of clay, organic material, boulders or stones larger than 8 inches, or construction debris. There shall be at least one foot of cover over the pipe before compaction of the final back fill by the use of self-powered compactors. Construction vehicles shall not be driven over the pipe until a three foot cover of properly compacted material is placed over the pipe. Compact to at least 95 percent Standard Proctor density as defined in ASTM D698, Standard Test Methods for Laboratory Compaction.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform field testing and quality control of corrugated-wall, smooth-interior HDPE gravity pipe, fittings, and specials in accordance with the requirements of the following Section:

1. Section 33 05 05, Buried Piping Installation.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Cleaning:

1. During construction, all piping shall be thoroughly cleaned before placement and the lines kept free from foreign matter of whatever origin. The pipes shall be left thoroughly clean to the satisfaction of the Engineer.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required, to furnish, install, and test all buried piping as indicated in the buried piping schedule, complete and operational.

B. The following index of this Section is presented for convenience:

A. The following attached schedule is a part of this Section:

1. Schedule 33 06 01-1, Schedule of Buried Piping.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. 22 11 16 – Domestic Water Piping

B. 33 05 05 – Buried Piping Installation

C. 33 05 05.30 – Leakage Testing for Buried Piping

D. 33 05 33.13 – Corrugated-Wall, Smooth Interior HDPE Gravity Pipe

E. 40 05 06 – Couplings, Adapters, and Specials for Piping

F. 40 05 19 – Ductile Iron and Cast Iron Pipes

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Not Used

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SCHEDULE 33 06 01-1
BURIED PIPING SCHEDULE

Service Name	Material	Wall Thickness/ Schedule/ Class	Type of Joint	Working Pressure (psig)	Test Type	Test Pressure (psig)	Interior Coating	Exterior Coatings, Treatments	Remarks
RWLD Storm Sewer	RCP	Class IV	RG/BS	N/A	Exf/Inf	N/A	N/A	N/A	
RWLD Storm Drain	HDPE	Type S	BS	N/A	Hyd	9	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
RWLD Storm Sub-Drain	Perforated HDPE	Type S	BS	N/A	Hyd	9	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
Kensico Site Storm Sewer	HDPE	Type S	BS	N/A	Hyd	9	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
Kensico Site Electrical Building Roof Drainage	CIP	Extra Heavy	BS	N/A	Hyd	9	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
Kensico Site Electrical Building Sanitary Sewer	CIP	Extra Heavy	BS	N/A	Hyd	9	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
Kensico Site Potable Water – Main Service	DI	Class 56	RMJ/ RPOJ	140	Hyd	200	CL	AC + PEL	CL thickness shall be double the min thickness specified in AWWA C104/A21.4. PE shall conform to NYCDEP Standard Sewer and Water Main Specifications.

Kensico Site Potable Water – Electrical Building / Police Booth Service	Cu	Type K	Brz	140	Hyd	200	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123

A. The following service abbreviations are used in Schedule 33 06 01-1:

Service:	Abbrev:
Relocated Westlake Drive	RWLD

B. The following pipe material abbreviations are used in Schedule 33 06 01-1:

Pipe Material:	Abbrev:	Pipe Material:	Abbrev:
304L Stainless Steel	304L SS	Ductile Iron	DI
316L Stainless Steel	316L SS	High-Density Polyethylene	HDPE
Brass	Brass	Polyvinyl Chloride	PVC
Carbon Steel	CS	Prestressed Concrete Cylinder Pipe	PCCP
Chlorinated PVC	CPVC	Reinforced Concrete Pipe	RCP
Cast Iron Pipe	CIP	Stainless Steel	SS
Copper	Cu		

C. The following joint type abbreviations are used in Schedule 33 06 01-1:

Joint Type:	Abbrev:	Joint Type:	Abbrev:
Bell and Spigot	BS	Soldered	Sld
Brazed	Brz	Solvent Weld	SW
Butt Weld	BW	Restrained Mechanical Joint	RMJ
Flanged	Flg	Restrained Push-on Joint	RPOJ
Lap Welded	LW	Rubber Gasket	RG
Mechanical Joint	MJ	Threaded	Thd
Push-on Joint	POJ	Welded	Wld

D. The following interior coating abbreviations are used in Schedule 33 06 01-1:

Interior Coating	Abbrev:	Interior Coating:	Abbrev:
Asphalt Coated	AC	Coal Tar Pitch	CTP
Basalt Coated	BC	EPDM (M-class) Rubber	EPDM
Ceramic Epoxy Coated	CEC	Glass Lined	GL
Ceramic Epoxy Lined	CEL	Polyethylene Lined	PEL
Cement Lined	CL		

E. The following exterior coating and treatment abbreviations are used in Schedule 33 06 01-1:

Exterior Coating, Treat.:	Abbrev:	Exterior Coating, Treat.:	Abbrev:
Asphalt Coated	AC	Galvanized	Galv
Epoxy	Epx	Polyethylene Encasement	PE

F. The following testing abbreviations are used in Schedule 33 06 01-1:

Test Type:	Abbrev:	Test Type:	Abbrev:
Exfiltration	Exf	Infiltration	Inf
Hydrostatic	Hyd	--	--

PART 1 GENERAL

1.01 SUMMARY

A. Requirements for furnishing and installing precast and cast-in-place manholes, catch basins, pond outlet structures, outlet structure retaining walls, and other structures in sanitary sewers and storm sewers including all appurtenances.

B. Concrete drainage structures include, but are not limited to, inlets, catch basins, pond outlet structures, outlet structure retaining walls, area drains, manholes, pipe cradles and encasements, and splash pads.

C. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

1.	Section 03 21 00	-	Reinforcing Steel
2.	Section 03 30 00	-	Cast-in-Place Concrete
3.	Section 03 41 00	-	Precast Structural Concrete
4.	Section 05 52 13.05	-	Welded Pipe Railing (Stainless Steel)
5.	Section 05 56 00.01	-	Miscellaneous Metal Castings
6.	Section 33 05 05.30	-	Leakage Tests for Buried Piping

1.04 REFERENCES

1. ACI 318 - Building Code Requirements for Structural Concrete and Commentary
2. ASTM C32 - Sewer and Manhole Brick (Made from Clay or Shale)
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
5. ASTM C139 - Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
6. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
7. ASTM C144 - Aggregate for Masonry Mortar
8. ASTM C279 - Chemical-Resistant Masonry Units
9. ASTM C443 - Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
10. ASTM C478 - Circular Precast Reinforced Concrete Manhole Sections
11. ASTM C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
12. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
13. AWWA C302 - Reinforced Concrete Pressure Pipe, Non-cylinder Type

14. City of New York Department of Environmental Protection Sewer Design Standards

15. NYSBC - Building Code of New York State

16. 29 CFR 1910.23 - Guarding Floor and Wall Openings And Holes

1.05 DESCRIPTION

A. Design Requirements

1. Except as otherwise shown or specified, construct sewer manholes and catch basins of precast reinforced concrete sections conforming to ASTM C478.

2. Unless otherwise shown, manholes and catch basins shall be built in accordance with the latest version of the New York City Department of Environmental Protection Sewer Design Standards and Standard Sewer and Water Main Specifications.

B. Construction of Manholes

1. Manhole Base Section: Unless otherwise shown, provide manhole base sections consisting of a base riser section with an integral floor. When benches are made at the manufacturing site, provide concrete used for benched inverts conforming to the requirements for concrete used for precast sections. When benches are made in the field, Class 45 concrete may be used. Benches shall be float finished and sloped to drain.

2. O-ring Joints: Join riser, cone and flat slab top sections with O-ring rubber gasket joints or self-sealing butyl gaskets, as shown in the Sewer Design Standards. Fill voids in the joints completely with mortar after assembly of the sections.

C. Precast Products

1. Unless otherwise shown or specified, precast concrete products shall be used for sanitary and storm sewer structures.

2. The number of joints in manhole and catch basin riser sections shall be kept to a minimum by using sections 8'-0" long in so far as possible. Joints shall be tongue and groove type conforming to AWWA C302, with continuous steel reinforcement in the tongue and bell.

3. Wet-cast methods only shall be used. Forms shall leave the surfaces smooth and free of irregularities or honeycombing.

4. Unless otherwise shown or specified, the following design loadings shall be used with 30 percent impact allowance in roads and 15 percent elsewhere.

a. Earth = 130 pcf

b. Wheel = H-20

5. Unless otherwise shown or specified, wall thickness for manholes and catch basins shall be not less than:
   a. 5 inches for walls
   b. 8 inches for top slab
6. No more than two (2) tapered lifting holes shall be provided per section of manhole or lifting holes shall be filled with tapered rubber plugs.
7. The point of intersection (P.I.) of pipes shall be marked with a pin in the manhole floor.
8. The date of manufacture and the manufacturer's trademark shall be marked inside each manhole and catch basin barrel.

D. Pond Outlet Structures Fall Protection Railing

1. Pond Outlet Structures installation shall include fall protection railing as shown in Contract Drawings.
2. Pond Outlet Structure shall provide adequate foundation support for fall protection railing in accordance with OSHA criteria.
3. Pond Outlet Structure Fall Protection Railing shall be final coated or shop fabricated with black vinyl coating.

E. Pond outlet structure retaining wall.

1. Contractor shall prepare retaining wall design in accordance with the NYSDOT highway manual - chapter 9 Figure 9.4-15a. See Contract Drawings.

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Shop and field test reports of concrete samples tested in an approved laboratory.
2. Drain inlet frame and pre-cast collar connection details
3. Shop drawings shall include calculations. Shop Drawings shall be signed and sealed by an Engineer licensed in New York State.

B. Pond Outlet Structures and Fall Protection Railing.

1. Contractor shall prepare and submit for approval shop drawings and calculations, signed and sealed by a New York State licensed Engineer for

the pond outlet structure and fall protection railing, in conformance with OSHA standards 29 CFR 1910.23, the NYS Building Code and ACI 318.

a. The Contractor shall reference the Contract Drawings for pond outlet structure dimensions, handrail clearances, construction notes, minimum design loads, suggested details, and other design criteria. Pond outlet structure calculations shall demonstrate adequate performance for minimum loads and orientation provided in Contract Drawings, in accordance with Section 03 41 00 – Precast Structural Concrete for all concrete appurtenances.

b. Shop drawings shall show coordination of anchorages for railing including sleeves, concrete inserts, anchor bolts, and items with integral anchors.

c. Calculations shall demonstrate adequate structural reinforcement for fall protection railing performance in accordance with Section 05 52 13.05 – Welded Pipe Railings (Stainless Steel), and OSHA Standard 29 CFR 1910.23.

C. Pond Outlet Structures Retaining Wall.

1. Contractor shall prepare and submit for approval shop drawings and calculations, signed and sealed by a New York State licensed Engineer for the pond retaining walls, in conformance with NYSDOT Standard Specifications.

a. The Contractor shall reference the Contract Drawings for pond retaining wall dimensions, elevations, construction notes, minimum design values, suggested details, and other design criteria. Pond retaining wall calculations shall demonstrate adequate performance for minimum loads and orientation provided in Contract Drawings, in accordance with section 03 30 00 - Cast-In-Place Concrete.

1.08 DELIVERY, STORAGE, AND HANDLING

A. General: Take every precaution to prevent injury to the structures during transportation and unloading. Unload manhole sections and other precast items using skids, pipe hooks, rope slings, or suitable power equipment, if necessary, and keep the items under control at all times. Do not allow the items to be dropped, dumped or dragged under any conditions. Follow applicable requirements specified in Contract Documents Damaged Section: If any precast manhole section or other structural unit is damaged in the process of transportation or handling, reject and immediately remove the item from the Site, and replace it at no increase in Contract Amount.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Precast Manholes shall be as manufactured by:

1. Monarch Precast Concrete Corp., Allentown, PA;
2. Precast Concrete Sales Company, Valley Cottage, NY;
3. Long Island Precast, Inc., Holtsville, NY;
4. Or approved equal.

B. Precast Inlets shall be as manufactured by:

1. Monarch Precast Concrete Corp., Allentown, PA;
2. Penn-Cast Products, Inc., Fredericksburg, VA;
3. Precast Concrete Sales Company, Valley Cottage, NY;
4. Or approved equal.

C. Precast Catch Basins shall be as manufactured by:

1. Monarch Precast Concrete Corp., Allentown, PA;
2. Penn-Cast Products, Inc., Fredericksburg, VA;
3. Long Island Precast, Inc., Brookhaven, NY;
4. Precast Concrete Sales Company, Valley Cottage, NY;
5. Or approved equal.

D. Precast Pond Outlet Structure shall be manufactured by:

1. Monarch Precast Concrete Corp., Allentown, PA;
2. Oldcastle Infrastructure, Inc., Farmingdale, NY;
3. Coastal Pipeline Products Corp., Calverton, NY;
4. Woodward's Concrete Products, Inc., Bullville, NY;
5. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Concrete, Steel Reinforcement and Aggregates: For precast manholes, catch basins, pond outlet structures, inlets, and other sanitary and storm sewer structures,

reinforced concrete, cementitious materials, aggregates and steel reinforcement shall conform to the requirements of ASTM C478 and Section 03 41 00 – Precast Structural Concrete. If concrete rings are used for adjusting manhole frames to grade, they shall conform to the requirements of ASTM C139. For cast-in-place structures, these materials shall conform to Sections 03 30 00 – Cast-in-Place Concrete and 03 21 00 – Reinforcing Steel.

B. Brick: If brick is used for adjusting manhole and catch basin frames to grade, it shall conform to ASTM C32, Grade MS, with minimum dimensions of 2 1/4 by 3 1/2 by 7 1/2 inches. Brick shall be new, solid, sound, hard burned throughout and uniform in size and quality.

C. Mortar: Provide mortar that is composed of one part Type II Portland cement or Portland pozzolan cement to two parts sand. Sand shall be natural sand that conforms to the requirements of ASTM C144.

D. Frames and Covers: Frames, covers, gratings and miscellaneous metal castings shown in the Sewer Design Standards or on the Contract Drawings for installation on manholes, catch basins, and other sanitary structures shall be gray iron and shall meet the requirements of Section 05 56 00.01- Miscellaneous Metal Casting.

E. O-Ring Rubber Gaskets: Provide O-ring rubber gaskets conforming to ASTM C443 for joining manhole sections.

F. Pond Outlet Structure Fall Protection Railing

1. Fall Protection Railing for Pond Outlet Structures shall be provided in accordance with Section 05 52 13.05 – Welded Pipe Railing (Stainless Steel).

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Concrete Strength: Manhole sections will be inspected and tested by an independent, certified testing laboratory, retained by the City, to establish the strength of the concrete and the adequacy of curing, to certify the date that the sections were cast and to confirm that the reinforcing steel has been properly placed. This inspection and testing will be performed by the laboratory at the manufacturing plant prior to shipment.

1. A minimum of one set of three cylinders will be taken each day that manhole sections are cast, with batch samples to be designated by the laboratory representative. At least one set of cylinders will be taken from each 9 cubic yards of concrete used in manhole section construction. These samples will be tested for strength. If the samples fail to meet specified minimum concrete strength requirements, all manhole sections

manufactured from the concrete from which the cylinders were made will be rejected.

2. The City reserves the right to core manholes either at the job Site or point of delivery to validate strength of concrete and placement of steel. If cores fail to demonstrate the required strength or indicate incorrect placement of reinforcing steel, all sections not previously tested will be considered rejected until sufficient additional cores are tested, at no increase in Contract Amount, to substantiate conformance to these requirements.

B. Acceptance of flat slab tops will be based on the tops passing a proof-of-design test in accordance with ASTM C478. Contractor shall test one flat slab top for each design.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Manhole Frames: Firmly embed manhole frames in mortar. Provide wedges or shims for accurate and level placing of the frames.

B. Connections to Riser Section: Manufacture riser sections with openings properly located for making connections to sewers. The minimum distance between a joint in a manhole section and the nearest edge of an opening for a connecting sewer and the diameter of such openings shall be as shown in the Sewer Design Standards.

C. Coatings: No exterior coating shall be used for precast structures.

D. Laying Masonry:

1. Bricks shall be wetted before applying mortar.

2. Full bed, end and side joints shall be formed in one operation.

3. Horizontal joints shall be 3/8 inch maximum and radial joints shall be 1/4 inch maximum.

4. Keyways shall be completely filled with mortar.

5. The total amount of adjustment by bricks or concrete rings shall not exceed 12 inches.

E. Precast Items:

1. Place on crushed stone bed or concrete cradle set level as shown.

2. Place backfill in even lifts on all sides to prevent overturning loads.

F. Stubs for Future Connections: Where shown, provide stubs or bells cast in walls and provide approved plugs or caps.

G. Grading:

1. Manholes and catch basins shall be installed such that covers will be at final grade.
2. Structures shall not project above finished pavements.
3. Structures in areas with temporary working grades shall be initially installed to match the temporary grade, and adjusted later to final grade prior to regrading.
4. Contractor shall be responsible for setting structures to the proper grade. The Engineer's review will be general and will apply to components only.

H. Pond Outlet Structure Fall Protection Railing

1. Fall Protection Railing shall be installed on Pond Outlet Structure in accordance with Section 05 52 13.05 – Welded Pipe Railing (Stainless Steel).

3.03 FIELD TESTING / QUALITY CONTROL

A. Test for leakage as required by Section 33 05 05.30 – Leakage Tests for Buried Piping.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 33 42 10 - REINFORCED CONCRETE SEWER PIPE
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall furnish and install reinforced concrete sewer pipe, fittings and specials.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

B.

1.03 RELATED SECTIONS

A. Section 33 05 05.30 - Leakage Testing for Buried Piping

B. Section 03 30 00 - Cast-in-Place Concrete

C. Section 03 41 00 - Precast Structural Concrete

1.04 REFERENCES

A. ASCE 15-98 - Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installation

B. ASTM A283 - Low and Intermediate Tensile Strength Carbon Steel Plates

C. ASTM A1011 - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

D. ASTM B127 - Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip

E. ASTM C31 - Making and Curing Concrete Test Specimens in the Field

F. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

G. ASTM C76 - Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

H. ASTM C361 - Reinforced Concrete Low-Head Pressure Pipe

I. ASTM C443 - Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

J. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile

K. ASTM C 1497 - Installation of Precast Concrete Sewer, Storm Drains, and Culvert Pipe Using Standard Installations

L. AWWA C302 - Reinforced Concrete Pressure Pipe, Noncylinder Type

1.05 DESCRIPTION

A. Design Requirements

1. Concrete shall conform to Sections 03 30 00 – Cast-in-Place Concrete and 03 41 00 – Precast Structural Concrete, and when tested at the end of 28 days shall have the following minimum compressive strengths:

a. PRECAST PIPE - 4,000; 5,000; 6,000 psi

b. MONOLITHIC SEWERS - 3,500 psi

c. CRADLES AND ENCASEMENT - 3,500 psi

2. Design: Provide the classes of reinforced concrete sewer pipe as shown or specified. Conform pipe designs to the following requirements.

a. Use diameter, wall thickness, compressive strength of concrete and area of circumferential reinforcement as prescribed for Classes I to IV in Tables 1 to 5 in ASTM C76, except do not use Wall A

thickness, elliptical reinforcing cages or quadrant reinforcing mats. Do not substitute modified designs for designs shown in the tables.

b. Provide special designs only for pipe with diameters and loads beyond those shown in Tables 1 to 5, pipe diameters that do not have steel reinforcement areas shown in the tables and pipe subject to thrust forces encountered in jacking operations. Conform special designs with the requirements of Section 7.2.2 of ASTM C 76, except do not use Wall A thickness, elliptical reinforcing cages or quadrant reinforcing mats without prior approval. Retain a Registered Professional Engineer, licensed in the State of New York, to prepare, sign and seal all special designs for pipe.

3. Precast reinforced concrete pipe shall conform to the requirements of ASTM C76 for circular steel reinforcement and the three-edge bearing strength test requirements for the load to produce the 0.01 inch crack and for the ultimate load. When the strength test requirements specified in the Contract Documents are greater than the strength test requirements of ASTM C76, the thickness of the pipe wall may be increased, the area of circular steel reinforcement increased, or a combination of these, all as approved by the Engineer.

4. Joints:

a. Provide joints for pipe, fittings and specials in gravity sewer and drain lines meeting the requirements of ASTM C443 and this Specification.

b. Provide joints for pipe, fittings and specials in concrete pressure lines with test pressures of 125 ft. or less meeting the requirements of ASTM C361 and these specifications.

c. Provide joints for pipe, fittings and specials in concrete pressure lines with test pressures over 125 ft. as described in the Contract Documents.

B. Schedules

1. Refer to the schedule contained in the Contract Documents for information on the piping that is to be constructed using the pipe materials and methods specified herein.

1.06 QUALITY ASSURANCE

A. General: Provide concrete pipe, fittings and specials that are precast or machine made and are the product of a company that can demonstrate by tests and installation records satisfactory experience in manufacturing concrete pipe of the quality and type specified.

1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. All diameters and classes of reinforced concrete pipe, fittings and specials and for concrete sills showing dimensions, strength and materials specifications and standards, joint details and reinforcement position
2. Area of all cages of reinforcing steel
3. A minimum clearance of one inch for each cage of circumferential reinforcing steel shown
4. Angle of the joint
5. Length and thickness of bell and spigot
6. Length and thickness of joint
7. Manufacturer, size and type of gasket
8. Manufacturer's recommendations for gap dimension and tolerance for a properly installed pipe joint
9. Signature and title of authorized representative of the manufacturer
10. All requirements of the latest ASTM Specifications for Precast Reinforced Concrete Pipe as called for in these specifications will be complied with in the manufacture of the pipe

B. Joint Compliance: Submit notarized affidavit of joint compliance with ASTM C443 and these specifications for each pipe size. The statement shall include date of test.

C. Quality Control: Submit certified results of all shop tests for approval.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Do not ship pipe to the Site until the pipe test results are certified by the Engineer.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Reinforced Concrete Pipe

1. Manufacture:

a. Do not use admixtures or blends in concrete without prior approval.

b. The manufacturer shall maintain a satisfactory manufacturing schedule and shall have adequate storage facilities so that the Work will not be delayed.

c. Cast pipe in steel forms to the exact dimensions shown, specified or required. Unless otherwise shown or specified, the inner and outer rings of reinforcement shall be concentric. Provide chairs and spacers to insure and maintain the proper position of reinforcement steel with respect to the protective concrete covering. Pipes in which reinforcing steel is placed beyond the tolerances allowed by ASTM C76 will be rejected. Use metal spacers at the top between the inner and outer forms to maintain uniform wall thickness in casting pipe. Where reinforcement mesh is used in the pipe, curve such reinforcement to shape on rolls having grooves for the longitudinal wires. In casting pipe, do not cut wires for form spacers or for other purposes. Provide continuous internal vibration of concrete during the pouring operation.

d. The Contractor will be responsible for meeting all requirements for the manufacture of precast pipe and checking at regular intervals all of such requirements.

2. Lengths: Manufacture all reinforced concrete pipe in lengths of not more than 16 feet and not less than 8 feet as follows, except where shorter lengths are required and approved for pipeline curves or at junctions with structures.

a. Furnish subaqueous pressure pipe in lengths of not less than 16 feet for pipe up to and including 84 inches in diameter. Pipe larger than 84 inches in diameter may be of lengths less than 16 feet, decreased on a sliding scale in accordance with the manufacturer's recommendations and as approved by the Engineer.

b. Furnish pressure pipe to be installed inland in lengths not less than 12 feet, except that pipe to be laid in sheeted trench shall be furnished in lengths not less than 8 feet.

3. Labeling: Immediately after the stripping of forms, all pipe manufactured for the Department of Environmental Protection as required under this contract shall be marked and identified with the following data: DEP, contract name and number, class and diameter of pipe, number of pipe, date

of manufacture and the name of the manufacturer. The numbering of the pipe shall be consecutive for each diameter of pipe. Brass lettering templates designed to stencil this information on each pipe shall be provided by the pipe manufacturer. The aforementioned data shall be stenciled on the inside and outside of each length of pipe with waterproof ink or paint. Any pipe arriving at the location of the Work without this information stenciled thereon will be rejected. At the end of each day of casting of the pipe, the manufacturer shall forward to the Engineer three copies of a report giving the diameters and the respective numbers of pipe cast that day.

4. Monolithic Sewers:

   a. Forms for monolithic concrete sewers shall be smooth, regular and true to shape. Forms which do not meet these requirements or which result in interior surfaces or thicknesses inferior to commercial precast concrete pipe shall not be used. Forms shall be thoroughly cleaned and approved by the Engineer before re-use. Sheeting shall not be used as exterior forms for monolithic concrete sewers.

   b. Concreting, unless otherwise approved by the Engineer, shall proceed in lengths of not less than 12 feet.

   c. Construction joints both longitudinal and transverse in monolithic concrete sewers shall have fabricated nickel-copper roofing sheet water stops conforming to the requirements of ASTM B127.

B. Reinforced Concrete Fittings and Specials

1. General: Provide reinforced concrete fittings and specials where shown, specified or required, and manufactured in accordance with the applicable sections of the respective standard for the adjoining pipe. Provide joints the same as in the adjoining pipe. Provide the interior surface of bends of the same smoothness and diameter as the adjoining pipe. Provide the center line radius of curvature of bends to be equal, in dimension, to the inside diameter of the pipe.

2. Strength: Design all reinforced concrete fittings and specials to have the same strength as the class of the adjoining pipe. Retain a Registered Professional Engineer, licensed in the State of New York to prepare, sign and seal all designs for fittings and specials.

3. Standard fitting such as bends, tees, wyes and reducers shall be formed of steel, cut, shaped and welded to the proper form. Interior and exterior concrete or mortar shall be placed in approved manner.

4. Special pieces and openings in standard pipe such as closures, wall fittings, adapters, manholes, air valve outlets, blow-offs and branches shall conform to details approved by the Engineer.

C. Joints

1. General: Rubber gaskets shall be stored in as cool a location as practicable, preferably at 70 degrees F or less. In no case shall gaskets be exposed to the direct rays of the sun for a total of more than 24 hours.

2. Gravity Sewer and Drain Lines:

   a. Manufacture all gravity sewer and drain pipe, fittings and specials with watertight joints using rubber gaskets in accordance with the requirements of ASTM C443. Provide a preformed groove in the tongue or spigot of sufficient depth to hold the gasket securely in place and produce the proper gasket compression. Reinforced concrete pipe joints shall be optional as to shape, except that no joint shall have a groove in which the wall thickness of the pipe is reduced to less than one-half, other than by a slight draw or taper, unless approved by the Engineer in writing.

   b. Manufacture the pipe with perfectly machined castings for forming the bells and spigots so that they will be true circles and when laid together the annular space for the rubber gasket will be perfectly uniform. The diameters of the bell and spigot surfaces, depended upon to compress the gasket, shall not vary from the theoretical diameters by more than 1/16 inch. The joint shall not project beyond the body of the pipe.

   c. Reinforce the bells of the pipe with a single cage of steel in which the circumferential members are the same gauge as those in the body of the pipe, but spaced on no more than 1 inch centers.

   d. The type and the manufacturer of the flexible rubber gaskets to be used shall be submitted for approval before pipe laying begins.

D. Concrete Pressure Lines:

   a. Provide all concrete pressure pipe, fittings and specials with watertight joints using rubber gaskets in accordance with the requirements of ASTM C361 and this Specification.

   b. Connect adjacent pipes by self-centering steel joint rings sealed with a continuous round rubber gasket. The joint shall be tight under normal conditions of service, and shall be sufficiently flexible to permit expansion and contraction as well as slight deflection due to normal earth settlement.

   c. Specially shape the rings which form the joint so that they will join with a close, sliding fit. The joint surfaces shall be such that the rubber gasket will be confined on all sides.

   d. Provide the spigot ring with an external groove accurately sized to receive the gasket. Special section steel for spigot rings shall conform to ASTM A283/A283M, Grade A or B.

e. Place the bell ring to permit gradual deformation of the gasket when the joint is assembled. The minimum thickness of bell rings shall be 3/16 inch. Bell rings for pipe sizes 42 inches and larger shall have a minimum thickness of 1/4 inch. Bell rings 1/4 inch and thicker shall conform to ASTM A283/A283M, Grade A or B. Bell rings less than 1/4 inch thick shall conform to ASTM A570/A570M, Grade A.

f. Precisely size each ring by expansion beyond the elastic limit of the steel and then gaging on an accurate template. Protect all exposed surfaces of both rings with a corrosion-resistant coating of zinc applied by an approved metalizing process after cleaning.

g. Provide a continuous rubber gasket with smooth surfaces free from imperfections. It shall be circular and shall fill the grooved recess between the assembled joint rings. Rubber compound used shall conform to the requirements of Section 4.4.10 of AWWA C302.

E. Curing

1. Cure all pipe, fittings and specials by steam or membrane curing. Water curing is not permitted.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Shop Testing

1. Test concrete sewer pipe in accordance with the applicable provisions of ASTM C497, as required by the ASTM Specification for the pipe and as specified herein.

2. Test cylinders: Each day the Contractor shall prepare two test cylinders made from the concrete used for manufacturing the pipe under this contract.

a. Make test cylinders in accordance with the requirements of ASTM C31 and cure and store them under identical conditions with the pipe. Test cylinders shall be properly marked for identification and dated.

b. The Engineer will have the cylinders tested to determine whether the concrete complies with the strength requirements. Of each pair of test cylinders, one cylinder will be tested at 7 days, and the other test cylinder will be tested at 28 days. Test cylinders will be tested in accordance with ASTM C39 and the cost of such tests will be borne by the City.

3. Test Pipe Sections:

a. When lengths of pipe are 8 feet or less, the Engineer will select one length from every fifty lengths of each diameter and class.

b. When lengths of pipe are more than 8 feet, the Contractor shall provide a pipe test specimen four feet long for every 50 lengths of each diameter and class. Each test specimen shall be manufactured, marked for identification and shall meet the strength test requirements as specified for the pipe it represents. The manufacturing and marking of the pipe test specimen shall be witnessed by the Engineer.

c. Where less than 50 lengths are required for any pipe diameter, one eight-foot length of pipe will be selected by the Engineer or one pipe test specimen shall be provided for testing purposes; however, the Engineer may waive this requirement at his discretion.

d. Age of Pipe: Pipe selected or pipe tested specimens provided as specified for testing purposes shall be at least twenty-eight days old but shall not be over thirty days old at the time of testing.

1) Due to unforeseen conditions beyond the control of the Engineer and the manufacturer, special permission will be given in writing by the Engineer to delay a test beyond the 30 day aging period.

2) The three-edge load bearing strength at 0.01-inch crack and the ultimate load strength of pipe tested after twenty-eight days will be corrected to the 28 day strength by deducting 1/2 of one percent of the recorded strength for each day beyond the twenty-eight day age.

3) The Contractor may request tests to be made on pipe which has aged at least fourteen days and not more than 28 days but the tests must meet the 28 day strength test requirement in order to be accepted by the Engineer for installation in the Work.

4. Basis of Acceptance: Conform to the basis of acceptance for reinforced concrete pipe to Section 5.1.1 of ASTM C76 and this Specification.

a. The Engineer will reject all pipe of the lot which the tested length of pipe represents if the actual or corrected strength of the pipe tested fails to meet the three-edge load bearing strength test requirements. However, if the eight-foot length of pipe selected by the Engineer fails to meet the three-edge loading bearing strength test requirements, the Contractor may request that tests be made on two other eight-foot lengths of pipe representing that lot from which the original pipe tested was selected. The Engineer will select these two lengths of pipe. Should the tests on these two lengths of pipe prove satisfactory, the lot, represented by these lengths of pipe will be accepted. Should the tests on one or two of these lengths of pipe prove unsatisfactory, no further tests on any other lengths of pipe

from this lot will be made, and all the pipe in this particular lot will be rejected.

b. The Engineer may accept precast pipe which meets the 0.01-inch crack strength test requirements but does not meet the ultimate load strength test requirements; however, the City will deduct 1/2 of one percent of the price bid per linear foot for that item which covers that particular pipe diameter and test strength requirements, for each one percent by which the ultimate load is below the required ultimate load. This deduction will be made on all pipe represented by the test specimen.

5. Proof-of-Adequacy Tests for Special Designs: Prior to manufacturing production run pipe of special design, test one pipe of at least four feet in length of each diameter and class by the three-edge-bearing method to confirm that the pipe meets both the 0.01-inch crack and ultimate load requirements for which it is designed.

6. Joint Adequacy Tests:

a. Prior to manufacturing production run pipe, fittings and specials, conduct all tests required by Sections 9 and 10 of ASTM C443 for each diameter of pipe.

b. Give two weeks' notice in writing, before the day of testing, to both the Engineer and the approved laboratory, to witness the tests. The Department of Environmental Protection reserves the right to have an inspector or authorized representative present at the time of the tests.

c. All manufacturers supplying reinforced concrete pipe to the Department of Environmental Protection shall, for each size of pipe and gasket combination submitted for approval, have on file with the Department a Certified Statement attested thereto by the City inspector or representative that the hydrostatic test on pipe and on rubber gasket was performed in accordance with the above-mentioned ASTM designation and passed.

7. Location of Tests: The pipe selected or the pipe test specimen provided for test shall be delivered by the Contractor to an approved testing laboratory and removed by the Contractor after the test has been made. The Contractor may request that tests be made at the manufacturer's plant; however, the pipe manufacturer shall provide an approved and certified testing machine with a hydraulically-operated jack and direct-reading gauges requiring no calibration.

8. Test Witnessing: All strength tests will be witnessed by the Engineer.

9. Costs of Tests: The Contractor shall pay all costs associated with tests and test witnessing.

B. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Install precast concrete sewer, storm drain, and culvert pipe in accordance with the requirements of the following Reference Standard(s):

1. ASTM C 1479 – Installation of Precast Concrete Sewer, Storm Drains, and Culvert Pipe Using Standard Installations
2. American Concrete Pipe Association – Concrete Pipe Installation Manual

B. Install all reinforced concrete sewer pipe, fittings and specials in accordance with the manufacturer's recommendations and approved shop drawings, and as follows.

1. Precast pipe lines shall be true to line and grade. The interior surface shall be smooth and uniform.
2. Season pipe 28 days prior to laying.
3. With the gasket in place, align the pipe, and draw the joints home with an approved tackle and apparatus. Prior to the use of such apparatus and method, demonstrate to the Engineer for approval the effectiveness and practicability of the proposed method of drawing the joints home.
4. The position and condition of the gasket will be examined from the inside of the pipe before successive pipe lengths are installed. If an unsatisfactory condition is located, the pipe shall be taken out and the operation of drawing the pipe together repeated with a new gasket.
5. Reinforced concrete sewer pipe shall follow installation type 2, from the Standard Installations Soils and Minimum Compaction Requirements Table.
6. Reinforced concrete sewer pipe shall be Class II from the Reinforced Pipe Classes for 0.01 inch Crack Per ASTM C 76 (lbs/ft/ft).

C. Jointing Pipe at Structures:

1. At manholes and other structures in precast concrete pipe lines, the construction may be of monolithic concrete. Submit details of such joints to the Engineer for approval.
2. Where precast concrete pipe for pressure pipe lines is joined to monolithic concrete pipe, cast iron or steel pipe, or other structure, the joint shall be similar to the joint between individual precast concrete pipes, enlarged if required. Submit details of such joints to the Engineer for approval.

3. Where provisions for future connections are required, provide similar joints and coat with an approved asphaltic compound for protection. If necessary, in the opinion of the Engineer, place a suitable collar entirely around the pipe at all such joints.

3.03 FIELD TESTING / QUALITY CONTROL

A. Test the reinforced concrete sewers for leakage after completion in accordance with Section 33 05 05.30 - Leakage Testing for Buried Piping

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required, to install all exposed piping complete and operational.

B. The following index of this Section is presented for convenience:

C.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 22 11 16 – Domestic Water Piping.

B. Section 22 11 19 – Domestic Water Piping Specialties.

C. Section 40 05 06 – Couplings, Adapters, and Specials for Piping.

D. Section 40 05 07 – Hangers and Supports for Process Piping.

E. Section 40 05 19 – Ductile Iron and Cast Iron Process Pipe.

F. Section 40 05 97 – Identification for Process Equipment.

G. Section 40 06 01 – Schedule for Exposed Piping.

H. Section 40 42 13 – Process Piping Insulation.

1.04 REFERENCES

A. Definitions:

1.	Buried Piping:	Includes all piping beginning at the outside face of a structures or foundation and extending away from structures. Buried piping includes piping beneath structures or foundations.
2.	Exposed Piping:	Includes all piping beginning at the outside face of a structures or foundation and extending inside. Exposed piping includes interior piping. Exposed piping also includes all piping embedded in concrete, as well as all piping that is permanently or intermittently submerged and/or installed in a subaqueous environment.

B. Reference Standards:

1.	ANSI/SMACNA	Seismic Restraint Manual.
2.	ASME	Boiler and Pressure Vessel Code.
3.	ASME B1.1	Unified Inch Screw Threads.
4.	ASME B31.1	Power Piping.
5.	ASME B31.3	Process Piping.
6.	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
7.	ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
8.	ASTM B32	Standard Specification for Solder Metal
9.	ASTM D2855	Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining PVC or CPVC Pipe and Piping Components with Tapered Sockets.

10.	ASTM F493	Standard Specification for Solvent Cements for CPVC Plastic Pipe and Fittings.
11.	AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
12.	AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances.
13.	AWWA C606	Standard for Grooved and Shouldered Joints.
14.	AWWA M11	Steel Pipe: A Guide for Design and Installation,
15.	AWWA M41	Ductile-Iron Pipe and Fittings.
16.	DIPRA	Installation Guide for Ductile Iron Pipe.
17.	NSF61	Drinking Water System Components Health Effects.

1.05 DESCRIPTION

A. This scope of this Section includes the requirements for the installation of exposed piping, except where installation requirements for exposed piping are shown or specified elsewhere in the Contract Documents. In addition:

1. The scope of this Section includes requirements for:

a. The jointing of exposed piping

b. The installation of gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, and tie rods.

c. Modifications and/or adjustments to existing exposed piping.

d. The installation of supports, restraints, and other anchors.

e. The cleaning, disinfecting, and field testing of all exposed piping.

2. The extent of exposed process piping is shown on the Contract Drawings. The Contractor shall provide additional exposed pipe as necessary and/or required to complete the Work as shown and specified. Exposed pipe service, pipe diameter, coating, lining, pressure rating, joint type, and testing requirements are specified in the following section(s):

a. Section 40 06 01, Schedule for Exposed Piping.

3. Where shown on the Contract Drawings, the Contractor shall provide all labor and materials for making connections between exposed piping and existing lines(s) installed under other contracts, including all specials required to connect exposed pipe to pipe of dissimilar material(s).

1.06 QUALITY ASSURANCE

A. Ductile Iron Pipe:

1. Refer to the latest edition of the DIPRA Installation Guide for Ductile Iron Pipe and the ductile iron piping manufacturer recommendations.

    a. Where requirements from the manufacturer, requirements specified by the DIRPA Installation Guide, and requirements specified herein differ, apply the most stringent requirement of the three.

B. Steel Pipe:

1. Welding of steel pipe and fittings:

    a. Welding procedures and welder qualifications shall conform to ASME Boiler and Pressure Vessel Code Section IX.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. Exposed piping submittals shall be submitted under the specification section number corresponding to the exposed piping material. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

    a. Shop Drawings:

        1) Catalog cuts and data sheets, including but not limited to:

            a) Specifications for all components of the exposed piping.

            b) illustrations in sufficient detail to serve as a guide for assembly and disassembly

            c) A parts schedule that identifies the materials to be used for the various piping components and accessories.

            d) Weights of all component parts.

            e) Details on joining methods.

            f) Details of pipe lining, coating, wrapping, insulation and painting.

            g) Copy of pipe coupling, special, and adapter details (pipe couplings, specials, and adapters shall be submitted for approval under Section 40 05 06, Couplings, Adapters, and Specials for Process Piping).

            h) Copy of expansion joint details (expansion joints shall be submitted for approval under the specification section in which they are specified)

i) Copy of pipe hanger details (pipe hangers shall be submitted for approval under Section 40 05 07, Hangers and Supports for Process Piping).

j) Copy of pipe insulation details (insulation shall be submitted for approval under Section 40 42 13, Process Piping Insulation).

b. Layout and Installation Drawings:

1) Shall include plans, sections, and details showing location, elevations, and clearly marked dimensions.

2) Piece numbers which are coordinated with the tabulated pipe layout schedule shall be clearly marked.

3) The scale used shall be the greater of the following two (2):

a) The scale used on the Contract Drawings that depict the process pipe for which the submittal pertains, or

b) A minimum scale of ¼-in = 1-ft - 0-in.

4) When special designs or fittings are required, the work shall be shown in large detail and the special or fitting completely described and dimensioned.

5) Include a north arrow.

6) Information on pipe supports, including:

a) Pipe support location.

b) Pipe support type.

c) hanger rod size.

d) Insert type.

e) All loads on the support (in either lbs. or kips.)

7) Locations where pipe and valve identification signs will be placed.

8) Location of pipe couplings, specials, and adapters.

9) Location of expansion joints.

10) Locations of pipe hangers and supports.

11) Extent of pipe insulation and heat tracing.

12) Extent of lining, wrapping, and coatings.

c. A tabulated pipe layout schedule for each exposed process pipe system. Submit a separate schedule for each pipe system and/or service. The pipe layout schedule shall include the following

information for each pipe section, fitting, and appurtenance that comprises that system:

1) Service.

2) Pipe size.

3) Working pressure.

4) Weight (in lbs.)

5) Joint type.

6) Wall thickness.

7) Piece number.

8) Laying length.

d. Calculations for the design of the support structures.

1) Design calculations shall be signed and sealed by a Professional Engineer registered in the State of New York.

2) Calculations shall include a summary of design criteria used in the design, including a description of each load case and load combination considered.

3) A tabulation shall be provided indicating vertical and horizontal deflections for the supports and individual members, determined for each load combination identified above.

4) A tabulation shall be provided giving the column vertical and horizontal reactions for each load combination.

e. For each exposed process piping system that contains expansion and swing joints, submit EMA calculations. Submit separate calculations for each pipe system and/or service.

f. For each exposed process piping system that contains valves, submit a tabulated valve schedule. Submit a separate schedule for each pipe system and/or service. The valve schedule shall include the following information for each valve:

1) Valve tag number.

2) Valve size.

3) Whether the valve is manual or actuated. If actuated, the type of actuator.

4) 100% open Cv value for control valves.

5) Upstream pressure (units of psig).

2. Information Submittals:

a. Certified Letters of Compliance:

1) Certificate of compliance with the requirements of the Contract Documents for pipe, fittings, couplings, sleeves, cleanouts and harnessing.

2) Certificate from an independent testing laboratory, approved by the City, for each welder assigned to the welding of pipe, fittings, and pipeline equipment.

3) Linings and Coatings:

a) Manufacturer shall submit a certificates or copies thereof attesting to the fact that the applicator met the requirements of the corresponding piping specification, adherence to all standards and testing specified therein, and that the material used was as specified therein.

4) Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards specified in the corresponding piping specification section.

b. Welding Procedures and Qualifications:

1) Certificates shall be of current issue and conform to the requirements of the applicable reference standards. In addition:

a) Certificates that all welders and welding operators have been qualified in accordance with ASME Boiler and Pressure Vessel Code Section IX.

b) Certificates stating that the welding of steel and stainless steel shall conform to the requirements of ASME B31.1.

2) Copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Structural Attachments:

1. Structural steel brackets required to support piping and appurtenances but not shown on the Contract Drawings shall be provided under this section.

2. Material for structural attachments shall be as specified under Section 05 12 00, Structural Steel Framing.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Identification:

1. Provide in accordance with Section 40 05 97, Identification for Process Equipment.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. All pipe coating injured in any way during transit or laying shall be satisfactorily repaired prior to placing the backfill.

1. Ample provision shall be made for the prompt and efficient repair of all abrasions and injuries.

B. Certificates of welding qualifications conforming to the requirements of ASME B31.1, Section 6 and its Supplements, shall be submitted to the Engineer for approval prior to proceeding with any pipe welding.

3.02 INSTALLATION

A. General:

1. All piping shall be erected to accurate lines and grades, permanently supported as shown, specified, or required.

2. Where temporary supports are used during construction, sufficient strength and rigidity shall be provided to prevent shifting or distortion of the pipe.

3. All work shall be accomplished using the best methods and procedures of recognized pipe fabrication in a good and workmanlike manner in accordance with the latest edition of the applicable standards referenced in the Contract Documents, including (but not limited to):

a. For ductile iron pipe:

1) AWWA C600.

2) AWWA M41.

b. For steel and stainless steel pipe:

1) ASME B31.3.

2) AWWA C206.

3) AWWA M11.

4. All exposed pipe, fittings, and appurtenances shall be installed in accordance with all of the following:

a. The manufacturer's printed instructions and recommendations.

b. The approved shop drawings.

c. As specified in the Contract Documents.

5. Routing:

a. Install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines, unless otherwise shown on the Contract Drawings.

1) Install horizontal lines true to line and elevation.

2) Install vertical lines truly plumb in all directions.

b. Where practicable, install piping in groups and parallel to building walls.

c. Avoid installing piping through ductwork or directly under electric light outlets, or interfering with other pipe, lines, conduit, etc.

d. Leave all corridors, walkways, work areas, and similar spaces unobstructed.

e. Clearance:

1) Clearances shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.

2) Provide a minimum clearance of 1-in. between pipe and other work.

3) Avoid installing pipe beyond furring lines as determined by the Architectural Drawings.

4) Provide a minimum headroom clearance under piping and pipe supports of 7.5 ft.

f. Small diameter piping and/or piping not shown on the Contract Drawings:

1) If specific locations and elevations are not shown on the Contract Drawings, install small diameter piping as specified herein, and as necessary and required to avoid ducts, equipment, beams, and other obstructions.

g. Multiple Pipe Runs:

1) In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member.

2) Spacing of the base support members shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

6. Placing:

a. Install bell and spigot pipe so that bells face the direction of laying, unless otherwise shown on the Contract Drawings.

b. For coated pipe, care shall be exercised in laying and cradling the pipe to prevent injury to the coating.

7. Cuts:

a. Use cutting methods and machines specially designed for cutting the pipe material and approved by the manufacturer. The following cutting methods are not acceptable:

1) "Squeeze" type pipe cutters

2) Cutting torches

3) Diamond points

4) Dog chisels.

b. Pie Lengths:

1) Full standard lengths of pipe shall be used in each pipe run in so far as possible.

2) Shorter lengths than standard shall be used only to complete a straight run of pipe, to connect to established locations of valves, equipment, bends, and the like.

3) Random lengths of pipe or cuttings from standard lengths shall not be coupled together when a full standard pipe length will fit in the pipe run.

c. Pipe shall be cut square, and not upset, undersized, or out of round, except as follows:

1) Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth.

d. Ends shall be carefully reamed and cleaned before being installed.

e. Make cuts carefully without damage to coatings or linings.

8. Jointing:

a. Thoroughly clean all pipe, fittings, valves, specials, and accessories before jointing.

1) Remove all cuttings and foreign matter from inside of pipe and tubing.

2) Clean joining area of pipe, fittings, and appurtenances as necessary and required and as per manufacturer instructions.

a) For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.

b. Use jointing methods recommended and approved by the pipe manufacturer.

c. Unions:

1) Provide a union downstream of each valve with screwed connections.

2) Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

d. Transitions from One Type of Pipe to Another:

1) Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

2) Connections between Dissimilar Metals:

a) Provide dielectric couplings, insulating couplings, unions, or other approved dielectric insulating devices, at all connections to pipelines or equipment of dissimilar metals, regardless of whether devices are shown on the Contract Drawings.

b) Refer to Section 40 05 15, Copper and Brass Process Pipe, for additional requirements for dielectric insulating devices for use with copper and brass process pipe.

9. Bends and Turns:

a. Do not spring or deform piping to make up joints.

b. Bending of pipe is not permitted.

1) Use fittings for all changes in direction.

c. Bends shall be of 45° or 90° unless otherwise shown on the Contract Drawings.

10. Plugs:

a. Shall match the materials, linings, and coatings of the process piping, and shall have a square head.

11. Transitions:

a. Reducing fittings shall be used for all changes in pipe sizes, even when not specifically shown on the Contract Drawings.

1) Unless otherwise shown or specified, use eccentric reducing fittings.

b. Do not use bushings, except where specifically shown on the Contract Drawings.

c. Nipples shorter than 4-in in length shall be Schedule 80.

d. Between pressure ratings:

1) Where lines of lower service rating tie into services, appurtenances, or equipment of higher service rating, the equipment, valve, or appurtenance between the two shall conform to the higher rating.

12. Drainage:

a. The Contractor shall provide all pipelines with a means for drainage at all low points in the lines.

1) Provide appurtenances for condensate drainage, regardless of whether such means is shown on the Contract Drawings and/or the approved shop drawings.

2) Drainage from gas lines shall be provided through an approved, double-valved, manually operated condensate trap.

b. Drainage valves and appurtenances shall be:

1) A minimum of 1-in. nominal diameter, unless otherwise shown on the Contract Drawings.

2) Adequately sized.

3) Of the same size as the drain pipeline specified herein.

4) Meet the requirements of Section 40 05 56, Process Valves, Smaller than Four-inch Diameter.

c. Where drainage valves or appurtenances are located so that liquids can discharge and cause damage to a structure or equipment, the Contractor shall provide drain pipe to the nearest gutter or drain.

1) Provide a single drain pipe, matching the size of the drain valve and appurtenances, for each drain valve on the carrier pipe.

2) Unless otherwise shown on the Contract Drawings, the drain pipe shall be of Schedule 80 CPVC conforming to the requirements of Section 40 05 31, Thermoplastic Process Pipe and the installation requirements for thermoplastic piping specified herein.

3) A quick connect coupling shall be provided at the end of the drain line for attachment of a hose.

13. Venting:

a. The Contractor shall provide all pipelines for liquids with vents at all high points in the lines.

1) Provide vents regardless of whether vent valves are shown on the Contract Drawings and/or the approved shop drawings.

b. Vents shall consist of the following three (3) components:

1) An automatic air release/vacuum relief valve.

a) The valve shall have a cast or ductile-iron body and cover, stainless steel internals, and Viton or Buna N seal, unless otherwise specified.

2) An outlet vent line.

a) The outlet vent line from the valve shall be of Schedule 80 CPVC conforming to the requirements of Section 40 05 31, Thermoplastic Process Pipe and the installation requirements for thermoplastic piping specified herein.

b) Vent line shall terminate at a point approximately 3 ft above the floor.

3) An isolation ball valve:

a) A ball valve shall be provided between the carrier pipe and the automatic air/vacuum release valve to allow removal of the automatic air/vacuum release valve for repair or replacement.

b) The body of the isolation valve shall be:

(1) For vents < 4-in.: Type 316 Stainless Steel.

(2) For vents ≥ 4-in.: The same material as the body of the automatic air/vacuum release valve.

c. Sizing:

1) For carrier pipelines ≤ 1-in.: Vents shall be the same size as the carrier pipe.

2) For carrier pipe > 1-in.: Vents shall be the size shown on the Contract Documents or 1-in., whichever is greater.

d. Vent valves (both the automatic air/vacuum release and isolation valve) shall meet the requirements of one (1) of the following Sections, depending on the size of the vent valve:

1) Section 40 05 53, Process Valves Four-inch Diameter and Larger.

2) Section 40 05 56, Process Valves, Smaller than Four-inch Diameter.

14. Drip Pans:

a. The Contractor shall provide drip pans under all metallic pipelines installed over electrical equipment and motors and conduct drainage to the nearest floor drain, gutter, or other drainage system with ¾-in. red brass pipe conforming to the requirements of Section 40 05 15, Copper and Brass Process Pipe, and installed as specified herein.

b. Make the connection between the drip pan and the brass drain pipe leak-tight.

c. Pitch the drip pan uniformly toward the drain pipe at a slope not less than ⅛-in. per lineal ft.

15. Insulation:

a. Refer to Section 40 06 01, Schedule for Exposed Piping, and the Contract Drawings for the extent of insulated exposed piping.

b. Insulation shall be installed after the installation and testing of exposed piping.

16. Hangers and Supports:

a. Install pipelines with supporting devices in accordance with requirements of Section 40 05 07, Hangers and Supports for Process Piping.

b. No piping shall be supported from metal stairs, ladders and walkways.

17. Restraints, Supports, and Thrust Blocks:

    a. Provide concrete and metal cradles, collars, kickers, and blocks as shown on the Contract Drawings.

18. Seismic Requirements:

    a. All piping and attached valves shall be supported and braced to resist seismic loads and in accordance with the SMACNA Seismic Restraint Manual.

19. Expansion and Contraction:

    a. The Contractor shall provide ample provisions for flexibility in all pipelines to compensate for expansion and contraction.

        1) Unless other forms of expansion compensation are shown or specified, the Contractor shall:

            a) Provide lengths of pipe shorter than the theoretical length to the extent of one half of the expansion, and install said lengths of pipe such that they may be free to expand without increasing the stresses imposed when cold.

        2) Otherwise, the Contractor shall install all piping with expansion devices to allow for proper expansion and contraction.

            a) Expansion devices shall allow the pipe to expand and contract freely without damage to any part of the piping system.

            b) Expansion devices shall include, but not be limited to: expansion joints, expansion couplings, swivel or swing joints or pipe bends, including such anchors as may be shown, specified, or required to make the devices effective.

    b. Cold sprung pipe:

        1) Install with metal filler pieces bolted between flanges or tack welded between weld joints.

        2) After the pipe, anchors, hangers and supports have been installed, the spacers shall be removed and the joint made.

    c. Swing Joints:

        1) For pipelines 2-in. nominal diameter or smaller, rated at working pressures up to 150 psig:

            a) Screwed end swing or swivel joints may be used.

b) Otherwise expansion shall be taken up with nipples and fittings as required.

2) A sufficient number of fittings and pipe lengths in connection with swing joints shall be provided to assure the absence of distortion of either the pipelines or branches.

d. Branch Tees:

1) Install branch tees on risers in locations that will allow the branch lines, when expanded by heat, to drain properly.

e. Pipe Expansion Bends:

1) Pipe bends of approved design for compensating thermal expansion when shown, specified or required shall be fabricated and furnished as herein specified.

2) In pipelines operating under high pressures or high temperatures in which offsets occur in alignment that may be subject to bending stresses excessive for the fittings, or where otherwise deemed necessary, use appropriate pipe bends to make the offset.

3) Where possible, all bends shall have radii equal to a least six diameters ($r = 6 \times d$) of the pipe and tangents or straight lengths of the pipe shall be neatly made, true to radius, free from buckles and flat surfaces.

f. Application guide and anchor requirements for expansion joints shall be in accordance with the recommendations of the manufacturer or the Standards of the EJMA.

g. The Contractor shall adjust all expansion devices after installation (but prior to operation) so that the pipelines shall be fluid-tight through the full range of operating conditions.

20. Wall Sleeves:

a. Where piping passes through walls, partitions, floors, roofs, or structures, provide wall sleeves of wearing material to prevent abrasion damage to piping.

1) Pipe sleeves shall be Schedule 40.

2) Sleeves through walls shall be flush with wall face.

b. Anchor sleeves to concrete and masonry walls as shown on the Contract Drawings.

c. All annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.

d. Do not install sleeves and pipes through structural members unless specifically shown on the Contract Drawings.

21. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:

a. At the end of each day of work or other interruption of pipe installation, the Contractor shall provide temporary blind flanges, plugs, caps, or bulkheads as necessary and required.

1) Plug all bells at dead ends, tees, and crosses.

2) Cap all spigot and plain ends.

b. To perform the testing of exposed piping as specified herein, or as per the sequence of work specified in the Contract Documents, the Contractor shall provide temporary blind flanges, line stops, plugs, and bulkheads suitable for and capable of withstanding the services and pressures for which they are intended.

1) Refer to Section 40 06 01, Schedule for Exposed Piping, for service and test pressures.

2) Temporary blind flanges, line stops, plugs, and bulkhead shall be compatible with and shall not damage the piping materials, coatings, and linings specified in Section 40 06 01, Schedule for Exposed Piping.

c. The Contractor shall uninstall all temporary blind flanges, plugs, caps, and when they are no longer needed for the Work.

22. Flow Measuring Devices:

a. If not shown on the Contract Drawings, position flow measuring devices in pipelines so that they have the amount of straight upstream and downstream runs recommended by the manufacturer, unless specific location dimensions are shown.

B. Ductile Iron Pipe:

1. Cutting:

a. Where field cutting of ductile iron pipe is permitted by the Engineer, ductile iron pipe shall be cut only by means of abrasive saws, hack saws, wheel type cutters or milling type cutters.

2. End Connections:

a. Mechanical Joint:

1) Ensure that cut ends are tapered and sharp edges are filed off smooth. Thoroughly clean the plain end (spigot) and the socket of the pipe or fitting.

2) Brush the socket, spigot end, gasket, and adjacent areas immediately before making joint with soapy water in accordance with AWWA C111.

3) Slip the gland and gasket over the spigot with the small side of the gasket facing the socket and the lip side of the gland facing the socket.

4) Insert the spigot into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.

5) Slide the gland towards the socket and center it around the pipe with the gland lip against the gasket.

6) Insert bolts and tighten nuts by hand.

7) With an ordinary ratchet wrench, tighten bolts evenly and alternately around. The pattern for tightening bolts shall be as per the manufacturer's recommendations. The bolt torque for mechanical joints shall be as per the DIPRA Installation Guide.

8) Do not deflect mechanical joint pipe after installation.

b. Push-On Joint:

1) Ensure that the spigot (plain) end is beveled as per the manufacturer’s recommendations and that sharp edges are filed off smooth.

a) Use a heavy file or grinder to bevel the plain end.

b) Do not use a saw blade to bevel the plain end.

2) Thoroughly clean the groove and the bell socket of the pipe or fitting. Also clean the plain end of the mating pipe or fitting.

3) Except for pipe lined or coated, use a wire brush to clean the exterior surface of the spigot and the interior surface of the bell.

a) Use a method for cleaning coated or lined portions of the pipe recommended by the coating or lining manufacturer.

4) Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.

a) Use a rubber gasket recommended by the pipe manufacturer.

(1) Do not use gaskets that have been scored or otherwise damaged.

b) Wipe clean rubber gaskets and flex gaskets until resilient. follow the manufacturer instructions for gasket resiliency when assembling joints in cold weather.

c) As per the DIPRA Installation Guide, make at least one (1) small loop and then insert the gasket into the socket.

(1) For pipe sizes larger than 20-in. nominal diameter, it may be necessary to make two loops in the gasket opposite each other.

(2) Make sure the gasket faces the correct direction as per the manufacturer's instructions and that it is properly seated.

5) Apply lubricant as per the manufacturer recommendations to the surface of the gasket that will come in contact with the entering spigot. Also apply lubricant to the outside of the entering spigot.

(1) As per the DIPRA Installation Guide, do not apply lubricant to the bell socket or the surface of the gasket in contact with the bell socket.

6) Push the spigot end into the bell socket of the mating pipe or fitting, ensuring the joint remains straight.

a) Pause insertion when the spigot end just makes contact with the rubber gasket.

b) After the gasket is compressed and before the pipe is inserted completely, carefully check the gasket for proper position around the full circumference of joint.

c) Final assembly shall be made by inserting the spigot end of the entering pipe past the gasket until it makes contact with the base of the bell.

7) Deflect push-on joint pipe only after the joint is assembled and not exceeding the deflection shown on the Contract Drawings and the maximum deflection specified in the DIPRA Installation Guide for the nominal diameter of pipe in question.

c. Grooved / Shouldered End Joints:

1) Grooved and shouldered end joints and their installation shall conform to the requirements of AWWA C606.

2) Thoroughly clean the joint ends to remove foreign matter. Except for coated pipe, use a wire brush to clean the exterior surface of the joint ends.

a) Use a method for cleaning the coated portion of the pipe recommended by the coating manufacturer.

3) Remove the bolts from the coupling.

4) Apply lubricant to the rubber gasket or inside of the coupling housing and joint ends as per the manufacturer recommendations.

5) Position and install the gasket over the gap between the joint ends.

6) Install the coupling housing around the gasket and over the grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand.

7) Tighten the bolts uniformly and according to the manufacturer's instructions.

d. Flanged Connections:

1) All flange faces shall be in perfect alignment with the holes straddling the vertical center line of the piping.

2) Properly center the gasket. Use full-face gaskets for flat-face flanges.

3) Gaskets shall be suitable for the service conditions referenced in Section 40 06 01, Schedule for Exposed Piping.

4) The gasket thickness shall be as recommended by the pipe manufacturer, with the exception that:

5) The minimum gasket thickness for raised face flanges shall be ⅛-in.

6) Bolts shall be of sufficient length so that when fully tightened, a minimum of two full threads shall extend beyond the nut.

7) Bolts shall be well lubricated over the entire thread length with a heavy graphite and oil mixture prior to the tightening operation.

8) Bolts shall be tightened with proper wrenches, care being taken to secure uniform pressure on the bolts and gasket and to avoid over stressing of the bolts, dishing of the flanges and compression of the gasket beyond its proper limits.

a) Commercial grade carbon steel bolts, ASTM A307, Grade B shall be tightened to obtain approximately 15,000 psi stress based on the root area of the thread.

b) Alloy steel bolts, ASTM A193, Grade B7 shall be tightened to obtain a stress of 45,000 psi.

c) The pattern for tightening bolts shall be as per the manufacturer's recommendations.

3. Support:

a. Provide supports for exposed ductile iron piping, fittings, appurtenances, and specials in accordance with the requirements of Section 40 05 07, Hangers and Supports for Process Piping. In addition:

1) Where shown on the Contract Drawings, ductile iron pipe beneath the ground floors of buildings or structures shall be encased in concrete to form an integral part of the floor slab.

a) This piping shall be included in the definition of exposed piping.

b) The reinforcement in the floor slab shall be placed and bent so that the pipe encasement is an integral part of the concrete structure.

c) Concrete for encasement:

(1) Shall be class 40.

(2) Shall conform to the requirements of Section 03 30 00, Cast-in-Place Concrete.

(3) Provide a 3-in. minimum depth of concrete between reinforcement and pipe or hanger components, and a 3-in. minimum depth covering on reinforcement.

C. Steel and Stainless Steel Pipe:

1. General:

a. Install in accordance with the best piping practice with a minimum exposure to the elements and to other corrosive conditions.

b. Before erection, all uncoated pipes shall be placed on end and hammered to remove scale and loose particles.

c. Pipe compounds:

1) For general service: Use an approved mastic metallic compound, Teflon tape, or approved equal shall be used.

2) For oil service: Use an approved compound resistant to oil.

3) For potable water: Use a NSF61 approved pipe compound.

2. End Connections:

a. Threaded Joint:

1) Pipe ends shall be reamed after pipe is cut to final length.

2) Threads shall be cleanly cut to the dimensions of the American Standard for Pipe Threads, ASME B1.1.

3) All burrs, dirt and foreign matter shall be removed and an application of pipe compound given to the threads of both pipe and fittings before assembly.

4) Apply a manufacturer's recommended joint compound prior to installation. Apply joint compound to male threads only.

5) Compound shall be eliminated at the inside of the joint.

6) Once a joint has been tightened, it shall not be backed off unless all threads are re-cleaned and new compound applied.

b. Flanged Connections:

1) All flange faces shall be in perfect alignment with the holes straddling the vertical center line of the piping.

2) Properly center the gasket. Use full-face gaskets for flat-face flanges.

3) Gaskets shall be suitable for the service conditions referenced in Section 40 06 01, Schedule for and Exposed Piping.

4) The gasket thickness shall be as recommended by the pipe manufacturer, with the exception that:

5) The minimum gasket thickness for raised face flanges shall be ⅛-in.

6) Bolts shall be of sufficient length so that when fully tightened, a minimum of two full threads shall extend beyond the nut.

7) Bolts shall be well lubricated over the entire thread length with a heavy graphite and oil mixture prior to the tightening operation.

8) Bolts shall be tightened with proper wrenches, care being taken to secure uniform pressure on the bolts and gasket and to avoid over stressing of the bolts, dishing of the flanges and compression of the gasket beyond its proper limits.

a) Commercial grade carbon steel bolts, ASTM A307, Grade B shall be tightened to obtain approximately 15,000 psi stress based on the root area of the thread.

b) Alloy steel bolts, ASTM A193, Grade B7 shall be tightened to obtain a stress of 45,000 psi.

c) The pattern for tightening bolts shall be as per the manufacturer's recommendations.

c. Welded Joints:

1) All welding of the following shall be in strict conformity with the Code for Pressure Piping, ASME B31.1, Section 6 and its Supplements:

a) Steel and stainless steel pipe.

b) Steel and stainless steel butt-welding fittings.

c) Steel and stainless steel fabricated fittings.

2) Welding shall not be done when the atmospheric temperature is less than 32°F or when surfaces to be welded are wet.

3) The surface to be welded shall be free from loose scale, slag, rust, paint, oil and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears and other defects which might affect proper welding.

4) Backing rings shall be used for all pipe welding butt joints unless otherwise specified.

a) Backing rings shall be of carbon steel with spacer nubs that strike-off or melt with the weld.

5) Field Welding of Stainless Steel:

a) No field welding of any stainless steel pipe or fittings shall be permitted unless otherwise shown on the Contract Drawings.

6) Welding of Cement Lined Steel:

a) Welding of cement lined steel pipe will be permitted only with the approval and under the observation of the Engineer where such welding is shown on the Contract Drawings.

7) The ends of the lined pipe for pipe-to-pipe joints shall be machine cut to provide an approximate bevel of 27½°.

   a) Bevels shall be accurately cut by machining or by a mechanically guided cutting torch.

   b) Ends may be chipped provided there is no damage to the cement lining.

8) Where fittings already having a bevel of 37½° are to be welded to pipe, pipe ends shall be beveled to a 17½° angle, making a total angle of bevel between joints approximately 55°. A ⅛-in. land shall be provided where possible.

9) Parts to be joined shall be approximately $^{1}/_{32}$-in. apart before tacking.

   a) Backing rings shall not be used at welded joints.

10) Piping shall be carefully aligned before welding and maintain alignment.

11) Small tack welds shall be made using a ⅛-in. electrode.

   a) Defective tack welds shall be removed before the final weld is made.

12) The first bead or layer of welding shall be laid by bridging across from bevel to bevel at the bottom of the groove just at the top of the land. A suitable crown reinforcement layer shall be made on the top of the joint to finish off.

   a) All layers of welding shall be of the same quality as the final welds and shall be fused thoroughly therein.

13) Direct current (dc) shall be used for welding, with the base material on the negative side.

14) Passes:

   a) The first pass shall be a stringer bead using a ⅛-in. electrode with a current of 80A to 90A at 50V to 55V.

   b) The second and succeeding passes shall be woven beads using a ⅛-in. electrode and a current of 90A to 100A at 55V to 58V.

   c) All passes shall be made slowly and with care not to burn through the land or the shoulder into the lining of the pipe.

   d) The joint shall not be hotter than 100°F.

e) For large size pipe, a $^{5}/_{32}$-in. electrode may be used, provided the temperature of the joint is held within this limit.

f) The surface of the finished welds shall have a bright metallic luster after cleaning, a fairly smooth and uniform contour with regular ripples and be free from overlaps, undercuts and excessive convexity.

15) No stress-relieving of welded joints is necessary unless the pipe wall thickness warrants it.

16) Welds shall be sound throughout, fused thoroughly and free from gas pockets, oxide, slag inclusions and surface porosity. The inside of the pipe shall be free from globules of weld metal, spacers or other material which would restrict the pipe area or become loose to enter the fluid stream.

17) Defective or unsound welds shall be corrected by removing and replacing the welds. Pipe or fittings which cannot be re-welded satisfactorily shall be replaced with new pipe or fittings at the Contractor's expense.

18) All welded joints will be visually inspected by the Engineer for defects beyond those acceptable in ANSI B31.1. Method of repair shall be in accordance with instructions as received from the Engineer.

19) Filling of Cement Lined Joints:

a) After the weld is completed, the joints in the lining shall be filled with a special compound of a wet slurry mix of the same cement used for the lining.

b) Where accessible from the end of the pipe, the welded joint shall be swabbed with cement using a paint brush thoroughly wetted with the cement slurry.

20) Repairing of Cement Lined Joints:

a) Any defects causing leaks in welded joints shall be repaired by welding without damaging the cement lining using the procedures specified herein.

3. Hangers and Supports:

a. In addition to the requirements of Section 40 05 07, Hangers and Supports for Process Piping, install steel and stainless steel pipelines in accordance with the applicable provisions of the Code for Pressure Piping, ASME B31.1, Section 6.

D. Copper and Brass Pipe:

1. End Connections:

a. Soldered Joints:

1) Cleaning:

a) After cutting, all surfaces to be soldered shall be thoroughly cleaned to a metal-bright finish, free from dirt, grease or other material before fluxing and soldering.

b) This cleaning shall be performed by using emery cloth, sandpaper, or steel wool.

c) Clean the outside end of the tubing for a length of ½-in. greater than the depth of the fitting. The inside of the fittings shall be cleaned in a similar manner.

d) Apply non-corrosive flux to both the outside of the tubing and the inside of the fitting.

(1) Acid solder or acid flux will not be allowed.

2) Assembly:

a) Assemble the joint by inserting the end of tube into full depth of fitting socket.

3) Solder:

a) Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.

4) Joining:

a) The surfaces to be joined shall be heated up slowly and uniformly to the melting point of the solder.

(1) Heating torches of sufficient size shall be used for heating of large fittings prior to soldering.

(2) Multiple tips or ring burners for use on combination torches may also be used.

b) The surface being soldered shall be maintained above the melting point of the solder for sufficient time to draw the solder completely into the joint.

c) Form continuous solder bead around entire circumference of joint starting at the bottom.

d) When the solder congeals to a plastic state the excess metal shall be removed with a cloth brush, leaving a fillet around the end of the fitting.

e) Full penetration of the solder uniformly throughout the entire socket is required.

f) The soldered joints shall be allowed to cool in still air until only warm to the hand after which the work may be quenched.

5) Inspection of Joints:

a) Any type of crack, pinhole, area of incomplete penetration, or similar defect will not be accepted.

b) Peening for closing up defects shall not be permitted.

6) Cleaning:

a) Remove all external and internal loose solder and flux after joint cools.

b. Threaded Joints:

1) Use threaded joints for copper process piping any of the following locations:

a) When open flames for soldering are impractical

b) At unions and connections to equipment and appurtenances.

c) Where shown on the Contract Drawings.

2) Flaring for Threaded Joints:

a) Cut the end of the copper tube square and ream to remove burrs.

b) Tubing to be flared shall be soft temper or annealed prior to flaring.

c) Tube that is out of round prior to flaring should be resized back to round.

d) Clean and polish contact surfaces of joints using an abrasive cloth.

e) Place flare nut over end of tube with threads closest to end being flared.

f) Insert appropriate length of copper tubing between flaring bar of flaring tool and position yolk with flaring cone over tube end and clamp yoke in place.

g) Ends of tubing shall be flared at an angle of 45°.

h) Turn the handle of the yolk clockwise without over-tightening.

(1) Use a flaring tool recommended by pipe manufacturer in accordance with the pipe manufacturer's instructions.

i) Pipe joint compound (nor any other material) shall be applied to the mating surfaces of the flare fitting and the flared tube end before attaching the flare nut to the fitting body.

3) Inspection of Flared Joints:

a) Cracked or deformed tubes will be rejected.

c. Unions:

1) Regardless of whether shown or indicated on the Contract Drawings, runs shall contain unions at all connections to valves and equipment, and at distances that permit convenient disassembly of piping and removal of equipment.

2. Pipe Flexibility

a. Make ample provisions for flexibility in all copper and brass pipelines.

3.03 FIELD TESTING / QUALITY CONTROL

A. Test all exposed piping in accordance with the requirements of Section 40 05 05.30, Leakage Testing for Exposed Piping.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 40 05 06 – COUPLINGS, ADAPTERS, AND SPECIALS FOR PIPING
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install, and test all couplings, adapters, and specials in pipelines, complete and operational.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting.

B. Section 22 11 16 – Domestic Water Piping

C. Section 33 05 05 – Buried Piping Installation.

D. Section 33 06 01 – Schedule for Buried Piping.

E. Section 40 05 19 – Ductile Iron and Cast Iron Pipe.

F. Section 40 42 13 – Process Piping Insulation.

1.04 REFERENCES

A. Reference Standards:

1.	ASTM A47	Ferritic Malleable Iron Castings.
2.	ASTM A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
3.	ASTM A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
4.	ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes.
5.	ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates.
6.	ASTM A536	Ductile Iron Castings .
7.	ASTM A744	Corrosion-Resistant Iron-Chromium-Nickel and Nickel-Base Alloy Castings for Severe Service.
8.	ASTM B26	Aluminum-Alloy Sand Castings.
9.	ASTM D2000	Classification System for Rubber Products in Automotive Applications.
10.	ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form).
11.	ASME B18.2.2	Fasteners in Customary Uses - Hex Nuts.
12.	ASME B31.1	Power Piping.
13.	ASME B31.3	Process Piping
14.	AWWA C104	Cement–Mortar Lining for Ductile-Iron Pipe and Fittings
15.	AWWA C110/A21.11	Ductile-Iron and Gray-Iron Fittings
16.	AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
17.	AWWA C116	Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
18.	AWWA C153	Ductile Iron Compact Fittings for Water Service

19.

20.	AWWA C213	Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
21.	AWWA C606	Grooved and Shouldered Joints.
22.	AWWA Manual M11	Steel Pipe - A Guide for Design and Installation.
23.	ANSI/NSF 61	Drinking Water System Components – Health Effects.
24.	ANSI/NSF 372	Drinking Water System Components – Lead Content.

1.05 DESCRIPTION

A. This Section includes requirements for providing couplings, adapters, and specials in accordance with applicable standards and regulations. In addition:

1. The scope of this Section shall include all buried and exposed process pipe.

2. The extent of piping is shown on the Contract Drawings. Buried pipe service, pipe diameter, pressure rating, joint type, and testing requirements are specified in Section 33 06 01 – Schedule for Buried Piping.

B. Pipe couplings for making field joints between plain end, grooved end, and shouldered end pipe and fittings shall meet the requirements of the Code on Power Piping, ASME B31.1.

C. Coupling design and construction shall facilitate easy assembly in the field.

D. Flexible couplings shall be designed and constructed to insure permanently tight joints under all conditions of expansion, contraction, shifting and settlement to which the pipelines may be subjected as a result of the operation and layout of the system in which they are installed.

E. Rigid couplings shall be designed and constructed to provide a tight joint and prevent pipe movement at the joint.

F. All water system components, including but not exclusive to couplings, adapters and specials, shall be in compliance with ANSI/NSF 372.

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturers:

1. The manufacturer(s) shall have a minimum of five (5) years of experience in the design and fabrication of coupling, adapter, and specials of similar size, capacity, and type to those shown on the Contract Drawings and specified in the Contract Documents, and shall show evidence of at least five (5) substantially similar installations in satisfactory operation.

B. Supply and Compatibility:

1. Couplings, adapters, and specials shall be designed, fabricated, and installed in accordance with the latest standards referenced herein.

C. Regulatory Requirements:

1. Use only NSF61-approved materials in potable water lines.

2. Pipe couplings for making field joints between plain end, grooved end, and shouldered end pipe and fittings shall meet the requirements of ASME B31.1.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition:

1. Action Submittals:

a. The Contractor shall submit the following Shop Drawings and material specifications for the approval of the Engineer:

1) Location of couplings, adapters, and specials in pipeline.

2) Catalog data showing dimensions, materials, and component parts of each type of coupling, adapter, or special.

3) Harnessing and restraints where required.

4) Associated pipeline materials.

5) Working and test pressures.

6) Testing procedures

7) Additional product data sufficient to demonstrate compliance with the Contract Documents.

2. Information Submittals:

a. Manufacturer instructions for handling, storing, installing, and adjusting of products.

B. Contractor shall forward process piping layout drawings to the coupling manufacturer for review and design recommendations. The coupling manufacturer shall address as minimum the allowable angular pipe deflection, flexibility, contraction, and expansion based on the maximum range of operating conditions.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver equipment and materials provided under this Section in accordance with the requirements of the Contract Documents.

B. The Contractor shall store equipment and materials provided under this Section in accordance with the requirements of the Contract Documents.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sleeve type couplings shall be as manufactured by:

1. For ductile iron pipelines:

a. ≤ 12-in.:

1) Style 138, as manufactured by Dresser Manufacturing, a Division of Dresser Industries, Bradford, PA.

2) 12" and smaller - Type 441, as manufactured by Smith-Blair Co., Texarkana, AR.

3) Or approved equal

b. > 12-in.:

1) Style 38, as manufactured by Dresser Manufacturing, a Division of Dresser Industries, Bradford, PA.

2) Larger than 12" - Type 411, as manufactured by Smith-Blair Co., Texarkana, AR.

3) Or approved equal

2. For joining dissimilar piping materials:

a. Style 162, as manufactured by Dresser Manufacturing, a Division of Dresser Industries, Bradford, PA.

b. Type 441, as manufactured by Smith-Blair Co., Texarkana, AR.

c. Or approved equal

3. For ductile iron pipelines:

a. Groove Type Coupling:

1) Flexible Type:

a) Victaulic® Style 31, with flexible radius grooves, as manufactured by Victaulic Co., Easton, PA.

b) Or approved equal.

2) Rigid Type:

a) Victaulic® Style 31, with rigid radius grooves, as manufactured by Victaulic Co., Easton, PA.

b) Or approved equal.

b. Shoulder Type:

1) Victaulic® Style 31, as manufactured by Victaulic Co., Easton, PA.

2) Or approved equal.

4. For copper pipelines:

a. Grooved-type coupling:

1) Rigid Type:

a) Victaulic® Style 606, as manufactured by Victaulic Co., Easton, PA.

b) Or approved equal.

B. Groove and shoulder type full flow fittings shall be as manufactured by:

1. Victaulic Co., Easton, PA.

2. Or approved equal.

C. Bolted split sleeve type couplings shall be as manufactured by:

1. Non-flexible couplings:

a. Victaulic® Depend-O-Lok® Type 1 or 2, as manufactured by Victaulic Co., Easton, PA.

b. Or approved equal.

2. Flexible couplings:

a. Victaulic® Depend-O-Lok® EXE Type 1 or Type 2, as manufactured by Victaulic Co., Easton, PA.

b. Or approved equal.

D. Thread Lubricant:

1. G-N paste (Molycote), as manufactured by Dow-Corning Industries, Auburn MI.

2. Or approved equal.

E. Expansion Joints (Metallic Type):

1. Holz, Rubber Company, Inc. SS Single Bellows Expansion Joints, Lodi, CA

2. Flexicraft Industries NLC SS Expansion Joints Chicago, IL

3. Or approved equal.

F. Expansion Joints (Non-Metallic Type, Elastomer):

1. Holz Rubber Company, Inc. Series 300, Lodi, CA

2. Flexicraft Industries Ultraspool Expansion Joint, Chicago, IL

3. Proco Products Series 230, Stockton, CA
4. Mercer Rubber Company Series 500/600, Hauppauge, N.Y.
5. Metraflex Company Style 100HT, Chicago, IL
6. Or approved equal.

G. Restraint Flange Adapters:

1. EBAA Series 2100 MEGAFLANGE Restraints, Eastland, TX
2. Romac Industries, Inc. ECF400 Restraint Flanged Adapters, Dallas, NC
3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. General:

1. Flexible couplings shall be designed and constructed to insure permanently tight joints under all conditions of expansion, contraction, shifting and settlement to which the pipelines may be subjected as a result of the operation and layout of the system in which they are installed.
2. Rigid couplings shall be designed and constructed to provide a tight joint and prevent pipe movement at the joint.

B. Couplings shall be either one of the following three types:

1. Sleeve Type:
   a. Sleeve type couplings shall be solid (axially un-split/unbolted) and have a middle ring or sleeve placed around the pipe joint.
   b. The middle ring shall be sealed by two wedge-shaped gaskets evenly compressed by follower flanges or rings tightened by bolts and nuts.
2. Groove and Shoulder Type:
   a. Groove and shoulder type couplings shall have a C-shaped (cross section) sealing gasket placed around the joint.
   b. The gasket shall be enclosed in a split-type housing which shall engage shoulders or grooves in the pipe.
   c. The housing shall be assembled by bolts and nuts.

C. Sleeve Type Couplings:

1. General:
   a. The maximum working pressure of the sleeve-type couplings shall not be less than:
      1) For pipe sizes ≤ 54 in.: 250 psig.

2) For pipe sizes > 54 in. 200 psig.

2. For Ductile Iron Pipe Lines:

a. Materials of Construction:

1) For pipe sizes ≤ 12 in.: ductile iron or steel.

2) for pipe sizes > 12 in.: steel.

b. The middle ring or sleeve shall be ductile iron, ASTM A536.

c. The middle ring or sleeve shall have flared or beveled ends.

d. The follower rings or flanges shall be of ductile iron, ASTM A536, or malleable iron, ASTM A47 (Grade 32510), for pipe sizes 12-in. and smaller, and shall be of steel ASTM A283/A283M (Grade A) for pipe larger than 12-in.

e. The middle ring shall not have a center pipe stop, unless otherwise specified, and shall have the same minimum dimensions as specified above for couplings for steel pipe.

3. Gaskets:

a. Gaskets shall be resilient, wedge-shaped gaskets with a maximum angle of 40° at the wedge end.

b. Gasket material shall be compatible with the type and temperature of the fluid in the pipeline, and shall be the material recommended by the manufacturer for the service specified in Section 33 06 01, Schedule for Buried Piping.

D. Groove and Shoulder Type Couplings:

1. General:

a. Couplings shall be of the following types:

1) For steel pipe ≤ 24-in.: grooved type

2) For steel pipe > than 24-in.: suitable welded steel collars shall be welded to the pipe ends, furnished by the same manufacturer as the groove and shoulder type coupling.

b. Unless otherwise specified, groove-type couplings shall conform to the requirements of AWWA C606.

2. Materials and Construction:

a. Housing:

1) Housing shall be in two or more parts, closely fitting the pipe and gasket.

2) Housing material shall be ductile iron, ASTM A536 (Grade 654512), except for stainless steel and aluminum pipelines,

which shall have housings of Type 316L stainless steel, ASTM A744 Grade CF-8M, and aluminum, ASTM B26, Alloy 356-T6, respectively.

b. Gaskets:

1) Gaskets shall be of materials compatible with the type and temperature of the fluid in the pipeline, and shall be of the material as recommended by the coupling manufacturer for the service specified in Section 33 06 01, Schedule for Buried Piping.

2) Gaskets shall be molded so that internal pressure tightens the seal. All gaskets shall be continuous, uniform in texture, and free from surface blemishes and defects.

E. Groove and Shoulder Type Fittings:

1. For steel and ductile iron pipe ≤ 24-in.:

a. Grooved end fittings shall be cast of ductile iron with working pressure ratings not less than shown in Table 40 05 06-2.

2. For steel and ductile iron pipe > 24-in.:

a. Fittings shall be provided with shoulders.

b. Working pressure ratings shall not be less than 150 psig.

c. Fabricated steel fittings shall be provided with extra-long end pieces to suit the coupling.

TABLE 40 05 06-2
WORKING PRESSURE RATINGS FOR GROOVED END FITTINGS

Nominal Pipe Diameter: (in.)	Working Pressure: (psig)
¾ - 6	1,000
8 - 12	800
14 - 22	300
24	250

3. For Copper Pipe:

a. Grooved end fittings shall be provided with rolled grooves and shall be designed for a working pressure not less than 300 psig.

F. Bolts and Nuts:

1. Bolts:
   a. Bolts shall be Type 316L stainless steel, ASTM A 193/A 193M, Grade B8, Class 2.
   b. Bolts shall have American Screw Threads, Coarse Thread Series, ASME B1.1.
   c. For all sleeve-type couplings, bolts shall be double radius head or buttonhead track type. The collars under the heads shall fit oval or square holes in the follower rings.
   d. For all groove-and shoulder-type couplings, bolts shall be track type oval neck bolts. The collars under the heads shall engage the oval slots in the housing.
2. Nuts:
   a. Nuts shall be Type 316L stainless steel conforming to ASTM A194/A194M.
   b. Nuts shall be American Standard Heavy Dimension Series, ASME B18.2.2.

G. Spool Type Expansion Joints:
1. For steel and ductile iron pipe ≤ 24-in.:
   a. Expansion Joints shall be metallic types or non-metallic (elastomer) types. Pressure rating shall be as scheduled and shown on the Drawings, and shall have a minimum 4 to 1 safety factor, at the rated burst pressure. Spool arches shall be open for application having flow velocities exceeding 16 ft/s, or filled arches shall be required. Flanges shall be full-pattern so that gaskets are not required. Flanges shall be drilled to ASME B16.5/B16.47 Class 150 and be an integral part of the body. All flanges attached to expansion joints shall be flat faced. Joints shall include two-piece back-up rings constructed of ductile iron or to match that of the adjoining piping system.
   b. Expansion joint cover and tube elastomer materials shall be as scheduled and detailed below:
      1) Fluorocarbon Rubber (FKM or Viton), meeting requirements of ASTM D2000 Type H Class K; having 65 to 95 Durometer Shore A, smooth finish.
      2) Ethylene Propylene Diene Monomer (EPDM), meeting the requirement of ASTM D2000 Type B Class A; having 40 to 80 Durometer Shore A, smooth finish.

H. Restraint Flanged Adapters for Misaligned Flanged Fittings:
1. For steel and ductile iron pipe ≤ 24-in.:

a. Gripping wedge style flange adapters for ductile iron mechanical piping applications shall be installed where shown on the Drawings, at locations where a disassembly gap is necessary to complete a piping assembly. Flange adapters shall be constructed of ASTM A536 ductile iron or ASTM A283, Grade C carbon steel. The flange adapter shall have flange bolt circles that are compatible with ASME B16.1 Class 125 and 250 flanges. Restraint for the flange adapter shall consist of individual mechanically actuated gripping wedges. Torque limiting actuating screws shall be incorporated into adapter to insure proper initial set of gripping wedges.

b. The flange adapters shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap between the end of the pipe and mating flange without affecting the integrity of the seal. The flange adapter shall have a minimum safety factor of 2.

c. Gaskets for the flange adapter shall be comprised of on Buna-N rubber.

d. Pressure rating of the flange adapters as scheduled and shown on the Drawings.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

2.05 PAINTING

A. All surfaces of the middle and follower rings of all sleeve-type couplings and the housing of all groove- and shoulder-type couplings shall be shop painted in conformance with the requirements of Sections 09 91 00 - Painting.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspection:

1. The Contractor shall not install damaged items until repairs are made in accordance with manufacturer's written instructions and approval by Engineer.

a. All damaged items requiring remedial work shall be returned to the manufacturer for repair or replacement.

B. Preparation:

1. Ends of pipe, fittings and couplings shall be cleaned of all scale, dirt and thick outside coatings.
2. Before assembly, the ends of pipe and/or fittings and the outside of the coupling gasket shall be lubricated as recommended by the manufacturer.
3. Fasteners shall be assembled using a thread lubricant.

3.02 INSTALLATION

A. Ends of pipe, fittings and couplings shall be cleaned of all scale, dirt and thick outside coatings. Before assembly, the ends of pipe and/or fittings and the outside of the coupling gasket shall be lubricated as recommended by the manufacturer. Fasteners shall be assembled using a thread lubricant equal to GN paste (Molycote) as manufactured by Dow-Corning, or Approved equal.

B. Install couplings, adapters, and specials for piping in complete accordance with the manufacturer's printed installation instructions and the approved shop drawings. In addition:

1. Couplings shall be assembled by tightening diametrically opposite bolts evenly and progressively.
    a. Bolts on sleeve-type couplings shall not be tightened beyond the point of stretching (when the mill scale on the shank begins flaking off).
    b. Bolts on groove- and shoulder-type couplings shall be tightened only until there is metal to metal contact between housing segments and the pipe.

C. Field Assembly of Groove-type Couplings:

1. Field grooving of pipe shall not be done unless approved by the Engineer, and then shall be limited to steel pipe 24-in. or under nominal diameter and to ductile and cast iron pipe 12-in. or under nominal diameter.
2. Field grooving shall be done only with special tools provided by the coupling manufacturer.

D. Harness for Sleeve-type Couplings:

1. In all pipelines under pressure, and elsewhere where shown, specified or required, sleeve-type couplings shall be harnessed.
    a. On all pressurized ductile iron pipe, couplings shall be harnessed with stainless steel tie bolts and nuts connected to flanges or fittings installed on the pipe on each side of the coupling as shown, specified or required for the pipe sizes and specified test pressures.
        1) The harnessed length from flange to flange shall not exceed 3 ft.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install, and test all hangers, supporting devices, and appurtenances shown, specified or required for pipes, fittings, valves, and other in-line equipment, complete and operational.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete.

B. Section 03 60 00 – Grouting.

C. Section 05 05 13.10 – Galvanizing.

D. Section 05 50 00 – Metal Fabrications.

E. Section 09 91 00 – Painting.

F. Section 23 07 19 – HVAC Piping Insulation

G. Section 23 21 13 – Hydronic Piping

1.04 REFERENCES

A. Reference Standards:

1.	ASCE/SEI17	Hangers and Supports
2.	ASTM A 36	Standard Specification for Carbon Structural Steel.
3.	ASTM A 48	Standard Specification for Gray Iron Castings.
4.	ASTM A 276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
5.	ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.
6.	ASTM A778	Standard Specification for Welded, Un-annealed Austenitic Stainless Steel Tubular Products.
7.	ASME - B31.1	Power Piping.
8.	AWS D1.1/D1.1M	Structural-Steel Welding Qualifications
9.	N.Y. Spec 32-P-6	Pipe, Special Castings, Valve Box Castings: Cast-Iron.
10.	MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture.
11.	MSS SP-59	Short Radius Welding Fittings.
12.	MSS SP-69	Pipe Hangers and Supports - Selection and Application.
13.	MSS SP-89	Pipe Hangers and Supports - Fabrication and Installation Practices.
14.	MSS SP-90	Guidelines on Terminology for Pipe Hangers and Supports.
15.	ASTM A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

16. Latest Edition of the New York State Building Code.

1.05 DESCRIPTION

A. This Section includes requirements for providing hangers and supports for process piping in accordance with applicable standards and regulations.

1. Included are rod hangers; clevis hangers, spring hangers; stanchion, roller and pipe pole supports and saddle stands; supports of structural steel; concrete saddles, concrete anchor blocks and bases, and all necessary guides, restraints, fastening devices, anchor bolts, pipe anchors and appurtenances.

2. The Contractor shall provide all temporary pipe supports required during construction.

3. The Contractor shall provide hangers and supports of sufficient strength to maintain the pipelines and appurtenances in proper position and alignment under the maximum combination of peak loading conditions to include pipe weight, process fluid/gas weight, process fluid/gas movement and pressure forces, thermal expansion and contraction, vibrations, seismic forces, and all probable externally applied forces for all operating conditions.

4. The Contractor may retain the services of a pipe support designer for providing the design of all piping hangers and support systems in accordance with the requirements of this Section, unless otherwise shown or specified.

5. Stressors in hangers, rods and brackets shall be in accordance with Table 2 of MSS-SP-58.

6. Hangers and support shall conform to the requirements of the New York State Building Code, and NFPA.

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturer and Pipe Support Designer:

1. Pipe hangers, supports, and appurtenances shall be standard products of the manufacturer specified herein.

2. Each type of hanger and support shall be the product of a single manufacturer.

3. The pipe support designer, if retained by the Contractor, shall have a minimum of five (5) years of experience in the design of pipe supports and shall show evidence of having completed at least five (5) substantially similar, successful pipe support projects of equal complexity as the systems specified.

a. The pipe support designer shall be a New York State Registered Professional Engineer.

b. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

B. Supply and Compatibility:

1. All hangers and supports for process piping included in this section shall be provided by the Contractor through a single, qualified ductile iron process pipe manufacturer.

2. The pipe and fittings shall be designed, fabricated, and installed in accordance with standards referenced herein.

C. Regulatory Requirements:

1. All hangers and supports shall conform to the applicable requirements of ASME B31.1, MSS SP-58, SP-59, SP-69 and SP-90, except as modified herein, and be of standard manufacture wherever possible, and best suited for the service required.

2. Unless otherwise approved, all hangers, supports and concrete inserts shall be listed with Underwriters' Laboratory, Inc. or approved equal.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

a. Shop Drawings shall include, but not be limited to:

1) Detailed drawings showing all hangers and supports for each piping system. Drawings shall show:

a) Location, installation, material, loads, forces, stresses and deflections of all hangers and supports.

b) Reaction forces imparted to structures to which hangers and supports are attached shall be shown.

c) Contractor shall provide detailed drawings of each pipe support. Each drawing shall contain enough information to verify the pipe support design and to allow the manufacture of the device. At a minimum, the Contractor shall submit:

(1) Scaled details of the device with dimensions.

(2) A table of applied forces and moments.

(3) A complete bill of materials.

(4) An isometric showing the applied forces and moments.

(5) Detailed connections to existing structure.

(6) Shop and field welds.

2) Manufacturer's catalogs and engineering data on all hangers and supports.

3) Load ratings.

4) Materials.

5) Installation details.

b. Submit the name and qualifications of the support and hanger engineer.

c. All drawings and design calculations included in the shop drawings shall be signed and sealed by a New York State Registered Professional Engineer.

d. Pipe support design shall include detailed load and movement calculations:

1) In the design of hangers, supports and anchors, unless otherwise shown or specified, pipe pressures shall be the maximum test pressures specified for pipelines carrying gases and twice the maximum test pressures specified for pipelines carrying liquids.

2) The following loads shall be included in pipe support design and pipe stress analysis:

3) The gravity force, including the weight of the pipeline plus the weight of any appurtenances, contents, insulation, etc.

4) The thermal expansion force developed by the restraint of free end displacement of the piping.

5) Hydrostatic forces developed by internal pressure during operation of the piping system.

6) Loading due to expansion joint reaction forces.

7) Seismic forces, as required by the latest edition of the New York City Building Code.

8) Occasional load calculations and pipe stress analysis shall be provided where required by the Contract Documents, Building Codes, or Standards referenced herein. Occasional loads include:

a) Seismic forces.

b) Pressure waves produced by sudden changes in fluid momentum, commonly referred to as water hammer.

c) Wind, snow or ice loads.

d) Safety valve thrust loads.

e. Calculated forces shall be included in the pertinent shop drawings as called for by the submittal requirements specified herein.

2. Information Submittals:

a. When equipment or appurtenance manufacturers have indicated that piping loads shall not be transmitted to their equipment or appurtenance, certification that from said manufacturer(s) that the Contractor's hanger and support design complies with said manufacturer(s) requirements. Submit a separate certification for each equipment or appurtenance bearing piping loads supported, in whole or in part, by Contractor's hanger and support design.

B. Each submittal package for pipe hangers and supports shall have the stamp of a New York State Registered Professional Engineer experienced in pipe support design.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver equipment and materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. Hanger inserts which are to be embedded in cast-in-place concrete shall be delivered in ample time not to delay the Work.

B. The Contractor shall store equipment and materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. Hangers and supports shall be protected from condensation, corrosion, and deterioration.

2. Hangers and support shall be properly protected from damage during construction, and shall be cleaned in accordance with manufacturer's instructions prior to installation.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. General:

1. The Contractor shall provide hangers and supports for all process piping and associated appurtenances, including, but not limited to valves, fittings, and specials, as follows:
    a. Where shown on the Contract Drawings: Provide hangers and supports as shown and as specified herein.
    b. Where not shown on the Contract Drawings: Provide hangers and supports in compliance with MSS SP-58 Table 2, and the requirements specified herein.
2. All hangers and supports shall allow minimum 3-in. of vertical adjustment.

B. Performance Requirements:
1. Delegated Design: Engage a qualified professional engineer, as defined in Article 1.06 of this Specification, to design trapeze pipe hangers and equipment supports.
2. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
    a. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
    b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
    c. Design seismic-restraint hangers and supports for piping and equipment [and obtain approval from authorities having jurisdiction].

C. Types:
1. Hangers for Single Pipes:
    a. Single pipes shall be supported by hangers suspended by rods from structural steel members, inserts in concrete ceilings and beams, bottom of trapeze hangers and wall mounted steel angle brackets. The strength of the rod shall be based on its root diameter.
    b. Except for piping subject to thermal expansion and contraction or as otherwise shown or specified, pipe hangers shall be adjustable clevis type MSS SP-58 Type-1.
    c. Piping subject to thermal expansion and contraction shall be supported on rollers.
2. Hangers or Supports for Multiple Pipes:

a. Multiple pipes, running parallel in the same horizontal plane, and adjacent to each other, shall be suspended by trapeze type hangers or supported on wall brackets. Trapeze hangers shall consist of channel sections supported from threaded rods or attached to concrete walls, columns or structural steel support members.

b. Except as otherwise specified herein, pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets, shall be anchor or pipe chairs as required.

3. Supports for Single Pipe:

a. Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods specified herein or as shown on the Contract Drawings.

b. Pipes shall be supported by adjustable stanchions, pipe saddle or roll supports with "U" bolts. Stanchions shall provide at least 4-inches adjustment and be flanged-mounted to floor.

c. Stanchions and saddle stands shall be of Type 316L stainless steel.

d. Pipe pole supports for pipe runs above ground, out-of-doors, and where otherwise required, shall consist of a suitable length of stainless steel pipe set upright in at least four feet of concrete; two stainless steel angles secured to the top of the pipe, at right angle and on each side; a stainless steel plate welded to the top of the angles to serve as a horizontal support for the pipes. Supports shall be provided with attachments in the form of stands, clamps, rolls, rods or similar devices of the screw adjustable type in the vertical direction.

e. Where specified or shown, column supports of built-up welded stainless steel shall be provided, as approved by the Engineer.

f. Pipe rollers shall be cast ductile iron, unless otherwise shown or specified. Hardware and appurtenances shall be stainless steel.

4. Wall Supported Pipes:

a. Single or multiple pipes located adjacent to walls, columns or other structural members, and an excessive distance from ceilings or underside of beams, shall be supported using stainless steel wall brackets, MSS SP-58 Type 32 or 33.

b. Where pipes rest on top of bracket pipe supports, pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs as required

5. Supports for Base Elbows:

a. Where pipes change direction from horizontal to vertical through a bend, a welded or cast base anchor support shall be installed at the bend to carry the load.

6. Supports for Vertical Pipes:

a. Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs.

b. Riser clamps shall be MSS SP-58 Type 42 or 8.

c. Insulation shall be removed from insulated pipes prior to installing riser clamps.

7. Supports for Process Air Piping:

a. Air piping shall be supported on stainless steel saddle type supports in the locations shown on the Contract Drawings and as specified.

1) Fixed supports, as located on the Contract Drawings, shall hold the pipe firmly in place, preventing any movement.

2) Sliding supports, as located on the Contract Drawings, shall allow longitudinal movement of the pipe to account for thermal expansion.

3) Guides, as located on the Contract Drawings, shall allow for longitudinal pipe movement while preventing lateral movement and maintaining alignment.

b. Supports shall be fabricated Type 316L stainless steel.

1) Saddles shall support 120° of the pipe circumference and at least 12-in. along the length of the pipe.

2) Saddles shall be bolted to the structural steel or concrete slab supports.

3) Straps shall be of Type 316 stainless steel.

4) All sliding supports shall be provided with 8-in. wide hold-down straps.

5) Straps shall not clamp down on the pipe, but shall allow the pipe to slide on the saddle to permit thermal expansion.

c. All sliding supports shall have a resilient bearing pad of Teflon attached to the saddle to allow the pipe to slide on the saddle to permit thermal expansion.

d. All hangers from overhead supports shall be saddle or cradle-type hangers which shall support the lower 120° of pipe circumference and a minimum length equal to one quarter the pipe diameter, but not have less than 6-in. or more than 12 in.

1) Where pipe is supported from existing slabs, new through-slab hanger rods shall be used instead of expansion bolts, except where otherwise authorized by the Engineer.

8. Supports for Pipelines with Thermal Expansion:

   a. Pipe rolls for single rod hangers: Stainless steel frame construction, ductile iron roller and stainless steel roller rod provided with threaded nuts; vertical adjustment permitted; for pipe sizes 6 in. or less unless otherwise approved.

   b. Pipe rolls for double rod hangers: Ductile iron roller, stainless steel roller rod, malleable iron threaded sockets which permit vertical adjustment.

9. Supports for Pipelines Subject to Temperatures Greater than 300°F:

   a. Spring hangers of heavy stainless steel construction.

10. Supports for Thermoplastic Pipes:

   a. All thermoplastic pipe attachments shall have a continuous bearing cradle or saddle on the lower 120° of pipe circumference and a minimum length of one quarter pipe diameter, but not less than 6-in. nor more than 12-in.

11. Supports for Copper & Brass Pipes:

   a. All copper and brass pipe supports shall be specifically manufactured for use with copper and brass pipe.

   b. Hangers shall be provided with a copper finish.

12. Hangers for Radiators:

   a. Support wall hung radiators on approved wall brackets or overhead hangers.

   b. Support wall hung radiators by all-metal brackets and plates that are screw adjustable after erection.

      1) Wall plates shall be made of stainless steel of size and shape to insure rigidity and strength and with a minimum resistance to expansion.

      2) Plates shall be fastened directly to walls, columns or pilasters with at least one ½-in. bolt, and with spacing of brackets not in excess of 42-in.

   c. Where rod hangers are specified or shown supporting wall radiators, supporting rods shall be not less than ⅝-in. in diameter.

13. Concrete Supports:

a. Where pipeline or mechanical equipment is shown, specified or required to be supported on concrete supports, supports shall be as specified herein.

b. Concrete supports for equipment shall be of a size and mass that will resist all forces, both static and dynamic, which may be developed by the equipment.

c. Concrete supports for pipe, fittings, valves and appurtenances shall be designed to carry the weight of the pipeline and appurtenances.

1) Cradles and anchor blocks shall safely withstand all stresses imposed by the pipelines, under all operating conditions.

2) Concrete cradles shall be shaped to fit the contour of the pipe.

d. Concrete supports shall be anchored to the floor of main structures by doweling or other approved means.

1) Anchor bolts, extension plates, saddle yokes and other hold-down devices in concrete bases shall be placed before pouring of concrete.

2) Expansion bolts shall not be used on new concrete supports except with the specific approval of the Engineer.

e. Concrete supports shall be not less than Class 25 as specified in Section 03 30 00, Cast-in-Place Concrete.

14. Protection Saddles for Insulated Pipe:

a. Contractor shall furnish steel protection saddles on all supports for insulated pipe.

b. For insulated pipes < 12-in. nominal diameter:

1) Provide saddles of No. 14 U.S. gauge stainless steel curved 180° for use with roller hangers or structural trapeze hangers.

2) Provide saddles of No. 16 U.S. gauge stainless steel curved 120° for use in clevis hangers.

3) Saddles shall be at least 12-in. long.

4) Saddle gripping side edges shall be turned up at least to the thickness of insulation.

c. For insulated pipe ≥ 12-in. nominal diameter:

1) Provide saddles of No. 12 U.S. gauge stainless steel with a welded centerplate to provide three-edge support.

2) Saddles shall:

a) Be at least as long as the pipe diameter.

b) Provide 120 degree coverage.

c) Have edge and centerplate depths equal to the insulation thickness.

D. Materials:

1. Hangers and supports shall conform to ASME B31.1.
2. Structural steel shall conform to ASTM A36 and ASTM A283.
3. Iron castings shall conform to ASTM A48 (Class No. 35).
4. Stainless steel shall conform to ASTM A 276:
   a. Use type 316 stainless steel for non-welded items.
   b. Use type 316L stainless steel for welded or fabricated items.
   c. Tensile Strength: 70,000 psi, minimum.
   d. Yield Strength: 25,000 psi minimum.
   e. Elongation in 2-in.: 35%.
   f. Reduction of area: 45%.
   g. For stainless steel pipe and tube: Use type 316L stainless steel conforming to the requirements of ASTM A778.
5. Rollers:
   a. Rollers, including stands and bases, shall be of cast iron, hot-dipped galvanized conforming to ASTM A123.
6. Expansion anchors for use in existing concrete structure:
   a. Material shall be Type 316 stainless steel.
7. Hanger Rods:
   a. Material shall be Type 316 stainless steel.
   b. Maximum allowable working stress shall be 5,800 psi, calculated based on the root diameter.
   c. Rods shall have a square head nut on top and running thread on bottom end.
8. Supports:
   a. Material shall be Type 316 stainless steel.
9. Appurtenances:
   a. Brackets, guides, restraints, rods, bolts, nuts and anchors shall be Type 316 stainless steel unless otherwise specified.
   b. Concrete inserts shall be of malleable iron with galvanized finish.

E. Sizing:

1. Size single and double rods based on the nominal pipe diameter in accordance with the Table 40 05 07-1.

a. Hanger loads shall be calculated based on the weight of pipe filled with water plus 50 psf of dead load.

TABLE 40 05 07-1
MINIMUM PERMISSIBLE HANGER ROD DIAMETER FOR NOMINAL PIPE SIZES

Pipe Size (in.)	Single Rod (in.)	Double Rod (in.)	Max. Load per Hanger (lbs.)
¾ to 1½	⅜	⅜	300
2	⅜	⅜	325
2½	½	⅜	350
3	½	⅜	400
3½	½	⅜	450
4	⅝	½	850
5	⅝	½	950
6	¾	⅝	1,075
8	*⅞	⅝	1,350
10	*⅞	⅝	1,750
12	*⅞	¾	2,200
14	*1	⅞	2,500
16	*1	⅞	3,075
18	*1	⅞	3,700
20	*1¼	1	4,425
24	*1¼	1	6,050

* To be used subject to the Engineer's specific approval

F. Concrete Inserts, Attachment Plates, and Clamps:

1. Hanger Rods:

a. Hanger rods up to ⅞-in. diameter: Shall be attached to new concrete structures using concrete inserts of Type 18 in MSS SP-58.

1) Inserts shall be malleable iron with galvanized finish.

a) The use of steel inserts is prohibited.

2) Design of the inserts shall permit the rods to be adjusted laterally in one plane and to lock the rod nut or head to the body.

3) The inserts shall be provided with openings or recesses to receive reinforcing rods.

4) To facilitate installation, slots shall be provided in the exposed flanges of the insert.

5) Inserts shall be rated to safely carry the maximum load which can be supported by the hanger rod.

b. Hanger rods larger than ⅞-in. diameter: Shall be attached to new concrete by means of approved hook anchors as shown on the Contract Drawings.

c. All hanger rods shall be attached to existing concrete structures using stainless steel expansion anchors as specified in Section 05 50 00 - Metal Fabrications.

2. Steel beam clamps:

a. Shall be malleable iron.

b. For wide flange or I-beams: conform to MSS SP-58 Type 28 or Type 29.

c. For channel sections or where it is necessary to locate the hanger rod off the beam centerline: conform to MSS SP-58 Type 20.

3. Steel U-shape beam attachments welded to the underside of beams and welded steel brackets fastened to structural steel columns:

a. Shall be subject to specific approval of the Structural Steel and Pipe Supports Shop Drawings.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Galvanizing:

1. Conform to the requirements of Section 05 05 13.10, Galvanizing, except as follows:

a. Malleable iron and concrete inserts shall be galvanized in conformance with the manufacturer's specifications.

B. Painting:

1. Conform to the requirements of Section 09 91 00, Painting.

C. Surfaces Protection:

1. Surfaces of hangers and supports in contact with aluminum, brass, plastic and copper pipelines or pipeline equipment shall be protected with an approved plastic coating to prevent abrasion.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. The City may elect to conduct shop inspections. The inspections may include but not be limited to: mechanical and chemical testing, material sampling, material certifications, traceability of parts, blasting and painting, visual and dimensional inspection, and free iron contamination check on stainless steel parts.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. The Contractor shall coordinate the Work such that all process piping hangers, supports, and restraining systems shall be installed and secured prior to the testing or activation of the process pipeline on which they are installed.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

C. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 INSTALLATION

A. Design:

1. Types of hangers and supports shall be kept to a minimum.

2. Wherever possible, pipe supports shall be designed using manufacturer's standard catalog products.

3. Hangers and supports shall be located to prevent vibration or swaying and to provide for expansion and contraction.

4. Hanger and support units installation methods shall be in accordance with manufacturer's recommendations.

5. Hangers and Supports for piping systems subject to thermal expansion and contraction, or to similar movements imposed by other sources, shall be designed to provide flexibility, and pipe stress analysis shall be provided.

a. Hangers and supports shall provide for expansion and contraction throughout the full operating temperature range.

6. Where resonance with imposed vibration and/or shock occurs during operation, suitable dampeners, restraints, anchors, etc., shall be added to remove those effects.

7. Hangers' rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.

8. Contact between dissimilar metals shall be prevented by use of copper plated, rubber or vinyl coated hangers or supports.

B. Hangers and Supports Embedded in Concrete:

1. Concrete embedded items shall be installed before concrete placement.

2. Embedded items shall be fastened securely to prevent movement during concrete placement.

3. Hangers and supports shall be adjusted and grout placed as specified in Section 03 60 00, Grouting, to bring pipelines to specified elevations.

C. Supports and Hangers for Horizontal Pipes:

1. Supports and hangers for all piping shall be placed no farther apart than shown below, unless otherwise shown or specified:

a. For ductile iron, steel, and stainless steel pipe:

1) Maximum spacing in accordance with Table 3 of MSS-SP-69. The designer should check the capacity of the steel or building structure to which the hanger or support is attached, and adjust the maximum spacing accordingly.

2) In addition, ductile iron pipe shall have a minimum of two supports per length and shall have a hanger or support adjacent to each end.

b. For thermoplastic pipe, based on the following nominal pipe diameters:

1) ≤ 1-in. dia.: 2 ft-6 in. center to center.

2) 1½-in. to 3-in. dia.: 4 ft-0 in. center to center.

3) 4-in. to 8-in. dia.: 6 ft-0 in. center to center.

4) > 8-in. dia.: 8 ft-0 in. center to center.

c. Tubing less than 1-inch diameter: In accordance with best piping practice and ASME B31.1, and as approved by the Engineer.

2. Hangers, supports, and accessories shall be located within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

3. Where hanger or support spacing does not correspond with joist or rib spacing, structural steel channels shall be attached to joists or ribs, and the pipes suspended therefrom.

D. Supports for Vertical Piping:

1. Spacing:

a. Vertical piping shall be supported at each floor and between floors by stays or braces to prevent rattling and vibration. Maximum spacing shall not exceed 25 ft.

2. Riser Clamps:

a. Riser clamp shall be placed under hub, fitting or coupling with approved solid bearing on steel sleeve.

b. Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.

3. Base elbows or welded equivalent shall be provided at vertical piping bases.

4. Top support shall have a horizontal connection, and provide for pipe expansion.

E. Pipelines installed under plumbing work shall be spaced in conformity with the requirements of the New York City Building Code or as specified herein.

F. Additional Supports:

1. In addition to any and all requirements for the placement of supports specified herein, the Contractor shall provide additional supports as follows:

a. Additional supports shall be placed immediately adjacent to any change in piping direction, at equipment, and on both sides of valves, expansion joints and couplings.

b. Suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub or flanged end.

c. Except where otherwise shown or required, horizontally valves 6-inches and larger shall be supported on each side of the valve, by pipe hangers or supports.

d. At all flexible couplings, supports shall be placed on each side and as close to the coupling as possible. Supports shall be the guide type which prevent axial movement from resulting in pipe deflection and misalignment.

e. Supports, anchorage and guidance for grooved end pipe shall be in accordance with the applicable sections of these specifications and the recommendations of the manufacturer.

G. Anchors and Sway Braces:

1. Anchors and sway braces shall be provided when required to hold the pipelines and equipment in position or alignment. Pipe anchors and braces for rigid fastening to the structures shall be attached to stainless steel anchor plates and anchor bolts set into the forms when placing concrete of new structures. Brackets and braces shall be attached to existing concrete structures with through bolts or expansion anchors.

2. Anchors, guides and restraints shall be provided for the proper operation of pipeline expansion joints.

3. Cast iron anchors shall be provided with stainless steel straps on piping, except where anchors form an integral part of pipe fittings and couplings or where an anchor of special design is required or shown on the Contract Drawings.

4. All pipe anchors, guides and restraints shall be designed to conform to ASME B31.1.

H. Expansion Joints and Flexible Couplings:

1. Supports, guides and anchors for flexible couplings and expansion joints shall be in accordance with the coupling and joint manufacturer's specification and the standards of the Expansion Joints Manufacturers Association.

I. Protection Saddles for Insulated Pipe:

1. Before placing the saddles, saddles shall be filled with either insulating cement or high density insulation cut to fit. For vapor barrier insulation, the barrier must be maintained; contact between hanger and support and bare pipe will not be permitted.

J. Adjustability:

1. Hangers and supports shall be capable of adjustment after placement of piping.

2. All points of adjustment for pipe and duct hanger rods shall be locked securely in place using double-nutting. Double-nutting means two nuts torqued directly against each other under each point of adjustment in addition to a third nut on top of the bracket. Damaging threads or tack welding as a method of locking adjustment is not permitted.

3. All threaded assemblies shall be double nutted or provided with pinned nuts. Alternately, tack welding of bolted assemblies may be acceptable unless provisions for vertical adjustment is required.

K. Any required pipe supports, for which the supports called for in this Section are not applicable, shall be fabricated or constructed from standard stainless steel shapes, concrete and anchor hardware, and shall be subject to the approval of Engineer.

3.03 FIELD TESTING / QUALITY CONTROL

A. Each pipe support system shall be tested in conjunction with the respective piping pressure tests.

1. Tests shall include cycling the piping system to duplicate operating conditions.

2. If any part of the pipe support system proves to be defective or inadequate, as evidenced by vibration or excessive movement, it shall be repaired or augmented at no additional cost to the owner/City.

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Touch-up shall be provided in the field, as required. Coating touchup shall be applied in accordance with the manufacturer's recommendations, and shall be free from spots and brush marks, to the satisfaction of the Engineer.

END OF SECTION

SECTION 40 05 19 – DUCTILE IRON AND CAST IRON PIPES
CONTRACT KENS-EAST-2

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified, and required to furnish, install, and test all ductile iron and cast iron process pipes complete and operational.

B. The following index of this Section is presented for convenience:

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting.

B. Section 31 23 16 - Excavation

C. Section 33 01 10.60 – Disinfection of Piping, Tanks, Structures, and Equipment.

D. Section 33 05 05 – Buried Piping Installation.

E. Section 33 05 05.30 – Leakage Testing for Buried Piping.

F. Section 33 06 01 – Schedule for Buried Piping.

G. Section 40 05 06 – Couplings, Adapters, and Specials for Piping.

H. Section 40 05 07 – Hangers and Supports for Piping.

I. Section 40 42 13 – Process Piping Insulation.

1.04 REFERENCES

A. Reference Standards:

1.	AASHTO T99	Standard Method of Test for Moisture-Density Relations of Soil Using a 2.5-kg (5.5-lb) Rammer and a 305-33 (12-in) Drop
2.	AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
3.	AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in., for Water and Other Liquids
4.	AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
5.	AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
6.	AWWA C116	Protective Fusion – Bonded Coatings for Interior and Exterior Surface of Ductile Iron and Gray Iron-Fittings
7.	AWWA C150	Thickness Design of Ductile Iron Pipe
8.	AWWA C151	Ductile-Iron Pipe, Centrifugally Cast, for Water
9.	AWWA C153	Ductile-Iron Compact Fittings, 3-in. through 24-in. and 54-in. through 64-in., for Water Service
10.	AWWA C213	Fusion – Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
11.	AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances.
12.	AWWA C606	Grooved and Shouldered Joints
13.	ASTM A74	Cast Iron Soil Pipe and Fittings
14.	ASTM A 536	Standard Specification for Ductile Iron Castings
15.	ASTM B98	Copper Silicon Alloy Rod, Bar and Shapes

16. ANSI/ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings
17. National Sanitation Foundation (NSF):
    a. NSF 61 - Drinking Water System Components - Health Effects.
    b. NSF 372 - Drinking Water System Components - Lead Content
18. CISPI 301 Hubless Cast Iron Sanitary System
19. CISPI 310 Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, and Vent Piping Application
20. DIPRA Handbook of Ductile Iron Pipe
21. NY Spec 24-C-38 Caulking
22. New York State Building Code
23. New York State Plumbing Code

1.05 DESCRIPTION

A. This Section includes requirements for providing ductile iron and cast iron pipe and accessories in accordance with applicable standards and regulations. In addition:

1. The scope of this Section shall include all ductile iron and cast iron pipe, fittings, and specials.
2. The extent of ductile iron and cast iron piping is shown on the Contract Drawings. Ductile iron and cast iron pipe service, pipe diameter, coating, lining, pressure rating, joint type, and testing requirements are specified in the following section:
    a. Section 33 06 01, Schedule for Buried Piping.
3. Ductile iron and cast iron pipe, fittings, appurtenances, and specials shall be furnished and installed complete with all necessary jointing materials, wall castings, wall sleeves, specials, adapters, and other appurtenances as shown on the Contract Drawings, as specified herein, and/or as necessary and required for a complete installation.
    a. Couplings for ductile iron pipe shall be provided as specified in Section 40 05 06, Couplings, Adapters, and Specials for Piping.
    b. Hangers and support for ductile iron and cast iron pipe shall be provided as specified in Section 40 05 07, Hangers and Supports for Piping.
    c. Cast iron soil pipe and fittings shall conform to the requirements of the latest edition of the New York State Building Code, and the "Handbook of Cast Iron Pipe."
4. Where shown on the Contract Drawings, the Contractor shall provide all labor and materials for making connections between ductile iron and cast

iron process pipe, including all specials required to connect ductile iron and cast iron process pipe to pipe of dissimilar material(s).

5. The scope of this Section shall include all painting, coating, lining, gaskets, harnesses, bolts, nuts, and other appurtenances and material required to provide and assemble the lines.

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturer:

1. The manufacturer shall have a minimum of five (5) years of experience in the design and fabrication of ductile iron and cast iron pipe, fittings, appurtenances, and specials of similar size, capacity, and type to those shown on the Contract Drawings and specified in the Contract Documents, and shall show evidence of at least five (5) substantially similar installations in satisfactory operation.

2. Linings and coatings:

a. Lining and coating manufacturer shall have a minimum of five (5) years of experience in protecting pipelines exposed to the service conditions specified in the Contract documents, and shall show evidence of at least five (5) substantially similar installations in satisfactory operation.

3. When linings and coatings are not applied by the manufacturer, the lining and coating Subcontractor shall have a minimum of five (5) years of experience in the application of the specified linings and coatings for the specified service, and shall show evidence of at least five (5) substantially similar installations.

B. Supply and Compatibility:

1. All ductile iron and cast iron pipe, fittings, appurtenances, and specials included in this section shall be provided by the Contractor through a single, qualified ductile iron and cast iron pipe manufacturer.

2. The pipe and fittings shall be designed, fabricated, and installed in accordance with standards referenced herein.

3. The manufacturer shall bear responsibility for the quality of all factory-applied linings and coatings, regardless of the location of application.

4. The manufacturer shall verify compatibility between the ductile iron process pipe, fittings, appurtenances, specials, and other Work.

C. Regulatory Requirements:

1. Ductile iron pipe shall conform to the American National Standards Institute (ANSI) and American Water Works Association (AWWA) Standards specified herein and recommendations as given in the Ductile Iron Pipe Research Association (24) “Handbook of Ductile Iron Pipe.”

2. Ductile iron pipe for City water shall conform to the rules and regulations of the Bureau of Water and Sewer Operation ; requirements contrary to such rules and regulations specified herein shall be disregarded.

3. Cast iron soil process pipe and fittings shall conform to the requirements of the latest edition of the New York State Building Code, and the "Handbook of Cast Iron Pipe."

4. The Work of this Section shall be performed by a plumber licensed by the local authority having jurisdiction

5. The process pipe and fittings covered by this Section shall be in compliance with NSF 61 - Drinking Water System Components Health-Effects and NSF NSF 372 – Drinking Water System Components – Lead Content.

1.07 SUBMITTALS

A. Submittals for all ductile iron and cast iron pipe shall comply with the requirements of Section 33 05 05 – Buried Piping Installation.

B. Contractor shall submit Shop Drawings for approval of the Engineer. Submittals shall include, but not be limited to, the following:

1. Shop Drawings.

2. Results of Certified Shop Tests.

3. Certified Letters of Compliance.

C. Shop Drawings shall include, but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various piping components and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete layout and installation drawings, including plans, sections and cross-sections showing elevations with clearly marked dimensions. Piece numbers which are coordinated with the tabulated process pipe layout schedule shall be clearly marked. Piping layout drawings shall indicate information on process pipe supports, location, support type, hanger rod size, insert type and the load in pounds.

3. Sleeve and wall penetration drawings.

4. Details of process pipe lining, coatings, wrapping, insulation and painting of all process pipes.

5. Weights of all component parts.

6. Tabulated process pipe layout schedule shall include the following information for all process pipe and fittings: service, pipe size, working pressure, joint type, wall thickness, piece number and laying length.

7. Flexible couplings, with harness details if required.

8. Calculations showing clamping force and torque required for flanged pipe joints.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. Pipes shall be loaded on properly padded saddles not less than 6-in. in width so that they do not bear against each other.

2. The whole load shall be securely fastened together as well as to any vehicle to prevent movement in transit.

3. Provide temporary end caps and closures on piping and fittings. Maintain end caps in place until installation;

4. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work and isolating parts of completed system;

5. Deliver materials to ensure uninterrupted progress of the Work

6. Ship equipment and material fully assembled except where partial disassembly is required by transportation regulations or for protection of components.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. Special care in handling shall be exercised during delivery, storage and handling of pipe to avoid damage and setting up stresses. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

2. When required for maintaining its circular shape and preventing distortion, each length of pipe shall be temporarily braced with an approved type of internal spider in each end of the pipe during erection.

3. Handling Coated Pipe:

a. Coated pipe shall be protected at all times and handled with equipment designed to prevent damage to the coating, such as stout wide canvas slings and wide padded skids.

1) The use of bare chains, cables, hooks, metal bars or narrow skids in contact with the coating will not be permitted.

b. All pipe handling and hauling equipment shall meet the approval of the Engineer before use.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Provide one set of all special access tee wrenches or keys for removal of clean out covers.

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ductile iron process pipe and fittings shall be as manufactured by the following:

1. American Cast Iron Pipe Co., Birmingham, AL;
2. McWane Inc., Birmingham, AL;
3. U.S. Pipe and Foundry Co., Birmingham, AL;
4. Or approved equal.

B. Expansion Joints:

1. Series 500, as manufactured by Mercer Rubber Company, Hauppauge, NY;
2. Or approved equal.

C. Flanged Adapters:

1. McWane Inc., Birmingham, AL;
2. Smith-Blair, Inc., Texarkana, AR;
3. Or approved equal.

D. Cast iron process soil pipe and fittings shall be as manufactured by the following:

1. Tyler Pipe Industries, Tyler, TX;
2. Charlotte Pipe and Foundry, Charlotte, NC;
3. Or approved equal

E. Vent Flashing:

1. Kester;
2. Lexcor;
3. Or approved equal

F. Floor Drain

1. Jay R.Smith Manufacturing Company;
2. Zurn Industries;
3. Or approved equal

G. Cleanout

1. J R. Smith Manufacturing Company;
2. Zurn Industries

3. Or approved equal

H. Trap

1. Eastern Foundry Company
2. Tyler Pipe
3. Or approved equal

2.02 MATERIALS / EQUIPMENT

A. Ductile Iron pipe and fittings:

Ductile iron pipe shall be in accordance with AWWA C151 for push-on, grooved or mechanical joint pipe and AWWA C115 for flanged pipe and shall be of grade 60-42-10 ductile iron. Buried ductile iron process pipe shall have mechanical or push-on type joints unless noted otherwise on the Drawings. All exposed ductile iron pipe shall have grooved or flanged type joints. Where pipe connects to equipment, flanged joints shall be used unless otherwise noted on the Drawings. The above standards cover ductile iron pipe with nominal pipe sizes from three (3) inches and including sixty-four (64) inches in diameter. Working pressure for the pipe shall be as called for in these Standards.

1. Pipe:

a. All pipe, including flanged pipe, for sizes up to and including twelve (12) inches shall have a wall thickness equal to Special Thickness Class 56 as specified in AWWA C151.

b. All pipe, including flanged pipe, for sizes over twelve (12) inches and up to fifty-four (54) inches shall have a wall thickness equal to Special thickness Class 55 as specified as specified in AWWA C151.

1. Fittings:

c. Fittings shall be ductile iron and shall be in accordance with AWWA C110 and shall be constructed of ASTM A536, Grade ductile iron. Any other fittings, not included in AWWA C110, shall conform in design and performance to the requirements of this Standard.

d. Blind, filler, companion and reducing flanges shall conform to ANSI/ASME B16.1.

e. Where compact fittings are shown or indicated, items shall be in accordance with AWWA C153.

2. Flanged Joints:

a. Threaded Flanges: Shall be solid, threaded, ductile-iron, flanges meeting the requirements of AWWA C115. Threaded flanges and pipe shall be assembled and faced by the pipe manufacturer; field or shop assembly will not be accepted. Threaded flanges shall be

screwed on tight without overstressing the threads and, when properly assembled, shall be concentric with the pipe.

b. The dimensions of all flanges for pipe fittings and specials and the number and sizes of bolts, up to and including 54-in., shall be in accordance with ANSI B16.1, Class 125 standard flanges.

c. Flanges shall be tapped where tap or stud bolts are required.

d. Bolts: Bolts shall be in accordance with Appendix A of AWWA C115 and as follows: Flanged joints shall be made with bolts or stud-bolts with a nut on each end. Bolts, stud-bolts and nuts shall be ANSI heavy dimension, semi-finish, with square heads and cold-punched hexagonal nuts. For bolts 1¾-in. in diameter and larger, stud-bolts shall be used. Bolt size shall be American Standard for ANSI Class 125 flanges. Where flanged joints are in manholes or submerged in tanks, bolts, stud-bolts, and nuts shall be silicon bronze, ASTM B98, Alloy A, of dimensions and sizes equal to steel bolts, stud-bolts, and nuts specified in Appendix A of AWWA C115.

e. Gaskets: Flange gaskets shall be in accordance with Appendix A of AWWA C115. They shall be full-face gaskets for flanged joints on 12-in. diameter and smaller pipe and shall be of the ring type for flanged joints on larger pipe.

f. After each flanged joint has been made, all bolt heads and nuts, and all surfaces of the flanges not to be painted shall be given two coats of asphaltic coating meeting the requirements of AWWA C151.

3. Grooved-Type Joints:

a. Shall be in accordance with AWWA C606 and Section 40 05 06 - Couplings, Adapters, and Specials for Process Piping.

4. Push-On Type Joints shall be designed in accordance with AWWA C600 and AWWA C111.

5. Expansion Joints:

a. Heavy Duty Rubber Expansion Joints shall be installed where shown on the Contract Drawings.

b. Each Expansion Joint shall be installed with minimum of two control rods and compression sleeves, and as shown on the Contract Drawings

6. Mechanical Joints:

a. Mechanical joints shall be assembled in accordance with AWWA C111 and AWWA C600 where required or shown on the Contract

Drawings. Joints shall be restrained or harnessed to withstand test and surge pressure.

7. Flanged Adaptors:

   a. Bolt hole and bolt patterns shall conform to the mating flange patterns as specified in the piping paragraphs. Bolts, nuts, and flange gaskets shall conform to the for the adjacent piping.

   b. Shall have ductile iron bodies.

   c. Shall have a rated working pressure of 175 psi.

   d. Pipe shall be anchored by using anchor studs drilled into the coupling and connected pipe for nominal pipe size 12-in. and smaller. For nominal pipe sizes over 12-in., pipe shall be restrained by harnesses or pipe supports as specified for sleeve type couplings.

8. Harnesses:

   a. Where shown, specified or required, harnesses for pipe with mechanical joints shall be provided.

   b. For ductile-iron pipe and fittings with mechanical joints that require harnessing, restrained type mechanical joint pipe will be considered as an alternate upon submission to the Engineer for approval.

   c. Joint Assemblies: Joint assemblies shall be designed to resist pullout of the joints at the test pressures specified for the piping system.

9. Sleeves:

   a. Sleeves shall be in accordance with AWWA C110. They shall be of ductile iron and shall be provided at all points where pipes will pass through walls and floors and where wall or floor castings are not provided. Unless otherwise shown, sleeves shall have intermediate collars not less than ½-in. thick and 1½ to 2-in. high located at the center of the wall.

   b. For exterior walls of structures, wall sleeves shall be plain ends and of flush wall design.

   c. Where shown on the Contract Drawings, modular wall seals shall be installed in the annular space between the pipe and the sleeve. In all other locations, caulk shall be installed in the annular space between the pipe and the sleeve. Caulking materials shall be in accordance with N.Y. Spec 24-C-38. For flanged pipe, sleeves shall be fabricated large enough to accommodate flanges.

10. Sleeve-Type Couplings:

    a. Sleeve-type couplings shall be in accordance with Section 40 05 06 - Couplings, Adapters, and Specials for process piping

b. Pipe and fittings for use with sleeve-type flexible couplings shall be plain end.

c. Sleeve wall thickness shall be the same as the associated ductile iron process pipe wall thickness.

11. Wall Castings, Connecting Pieces, and Special Fittings:

a. Wall castings and connecting pieces shall be in accordance with AWWA C110, 250 psi pressure rating, unless specified otherwise. Concrete encased wall castings connected to sluice gates and valves shall be cast from alloy iron, Ni-Resist Type 1, International Nickel Co. or approved equal. Wall castings and connecting pieces shall be furnished with ANSI Class 125 flanged ends, bell ends, flare ends and/or spigot ends where shown, specified or required.

b. Wall castings shall be of standard wall pipe dimensions, unless piping layout precludes their use, in which case special castings shall be furnished.

c. Design of Specials: Special fittings where required shall be of an approved design that meet the same specifications and have the same diameters and thicknesses as standard fittings. Any tees, crosses, elbows, laterals, reducers or other fittings of current ANSI or AWWA standard dimensions are not considered specials.

d. Intermediate Collar: Wall castings shall have an integrally cast intermediate collar not less than ½-in. thick and 1½-in. to 2-in. high located at the center of the wall unless otherwise shown.

e. Where space limitations prevent the use of through bolts for assembling flange connections, stud bolts shall be provided on wall casting flanges.

12. Cleanouts:

a. Cleanouts shall be furnished and installed where shown or specified.

b. Size: Cleanout openings shall be not less than 6-in. diameter for pipe 8-in. in diameter or larger. For pipe 6-in. in diameter or smaller, they shall be of the same diameter as the pipe.

c. Cleanout Covers: Cleanout covers which are blind flanges shall be in accordance with AWWA C110, except where conformation is required with the inside curvature of the pipe, in which case the covers shall be flanged plugs of proper shape with American Standard flange drilling.

d. Covers shall be fastened by means of steel studs and bronze nuts and shall be drilled and tapped for a 1½-in. diameter pipe connection.

e. Flange plugs shall be equipped with a dowel or other suitable means to provide proper setting.

B. CAST-IRON PIPE AND FITTINGS

Pipe and Fittings: Soil pipe and fittings shall be cast iron, extra heavy weight, hub and spigot meeting the requirements of ASTM A74 or hubless cast iron soil pipe and fittings meeting the requirements of CISPI 301. Hubless pipe and fittings shall not be used for buried pipe.

1. Pipe:

   a. Sanitary waste buried Cast iron soil pipe, ASTM A888, 2-inch through 15-inch size, bell and spigot joint.

   b. Sanitary waste above ground and in buildings: Cast iron soil pipe, service weight, centrifugally cast, ASTM A888, 1-1/2-inch through 10-inch size, “No-Hub” joint.

   c. Storm Drains: Cast iron pipe, ASTM A888.

   d. Pipe Identification: Identify all pipelines in accordance with Section 40 05 97 - Identification for Equipment.

2. Hangers and Supports:

   a. Provide hangers and supports as in Section 40 05 07 - Hangers and Supports for Piping.

3. Fittings:

   a. Cast Iron Pipe:

      1) Buried: Provide fittings of same weight and manufacture as pipe in which installed. Joints shall be bell and spigot push-on type with neoprene gasket.

      2) Aboveground and in buildings: "NO-HUB" type conforming to CISPI Standard 301 unless noted otherwise on the Contract Drawings.

      3) Threaded Drainage Pipe: Cast-iron, recessed, pattern drainage fittings.

4. Pipe Joints:

   a. Bell and spigot type joint shall be made with push-on compression type, and neoprene gasket conforming to ASTM C564.

   b. No-hub type joints shall be constructed of 24-gauge, type 304 stainless steel, with gasket guides, type 304 stainless steel screw clamp, and matching neoprene (ASTM C564) gasket that shall interlock with housing conforming to CISPI 310.

c. Joints in copper piping shall be made with tin-antimony solder (95-5) silver solder and non-acid flux.

d. Joints in threaded piping shall be made with Teflon tape or non-hardening pipe compound (Seal-Tite).

e. Neoprene gasket, compression type joints shall be in accordance with ASTM C564 for hub and spigot pipe. Hubless couplings for hubless pipe, shall be composed of a stainless steel shield, clamp assembly and an elastomeric sealing sleeve conforming to CISPI 310.

5. Vent Flashing:

a. Furnish 4 lb. lead flashing, material as recommended by roofing system manufacturer, or copper pitch pans for all vents through the roof. Type of flashing used shall be compatible with piping material.

6. Protective Coatings: Interior protective coatings (linings) and exterior protective coatings for pipe and fittings in the finished work shall be as follows and as indicated in the Section of Piping Schedules:

a. Interior bituminous lining shall be in accordance with AWWA C151.

b. Pipe and fittings not exposed in the finished work, or if the pipe schedules indicate that the pipe exterior is to have a bituminous coating, the pipe shall be coated in accordance with the requirements of AWWA CI 51.

c. If the pipe schedules indicate that the pipe exterior is to be painted, paint shall be in accordance with the requirements of Section 09 91 00, Painting.

7. Joints: Neoprene gasket, compression type joints shall be in accordance with ASTM C564 for hub and spigot pipe. Hubless couplings for hubless pipe, shall be composed of a stainless steel shield, clamp assembly and an elastomeric sealing sleeve conforming to CISPI 310.

8. Labels: Cast-iron Sanitary Soil and Storm pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPD or receive prior approval of the Engineer.

9. Components

a. Floor Drains

1) The Contractor shall furnish and install all floor drains as shown on the Contract Drawings, or as herein specified. Drains shall have galvanized cast iron bodies, and threaded outlets.

2) Floor drains located in floors above slabs on grade shall be provided with flashing clamps with copper flashing extending 8 inches all around.

b. Cleanouts

1) Cleanouts shall be installed where indicated on the Contract Drawings, at the base of all stacks, on all traps and at all points where the direction of flow changes. The interior of each system must be accessible throughout.

2) All cleanout plugs in screwed fittings shall be solid cast brass of the screwed type. Cleanout plugs shall be the full size of the pipe up to 4 inches and shall be 4 inches for larger pipes. Cleanouts located behind walls shall be made accessible with access covers.

c. Air gap

1) Air gaps shall be installed where indicated on the Contract Drawings. Air gaps shall be J.R. Smith or approved equal.

d. Nipples

1) All nipples shall be made from new pipe with threads properly cut and ends reamed out to full inside diameter of pipe. All nipples with the unthreaded portion less than 3 inches long shall be made from extra-strong pipe. Close nipples will not be permitted.

e. Unions

1) "Tucker" connections shall be used instead of unions on all drainage and vent piping. All "Tucker" connections shall be standard, galvanized, screwed, recessed, drainage type.

f. Drip Pans

1) The Contractor shall furnish and install 16-ounce polished reinforced copper drip pans under all drainage piping which is to be installed over or near electrical control equipment or motors. The pans shall be constructed, drained, tapped and connected into the drainage system as approved by the Engineer.

g. Traps

1) Every fixture and drain shall be separately trapped. Traps shall also be provided where indicated on the Contract Drawings. All traps shall be of the water sealing type, placed as close to the fixture or drain outlet as possible. All traps shall correspond as to quality, material and thickness with

other fittings in the lines in which they are installed and shall be of approved type.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Coatings and Linings:

1. General:

a. Ductile iron pipe shall be lined and coated in accordance with the piping schedule(s) included in the following Section(s):

1) Section 33 06 01, Schedule for Buried Piping.

b. All bolts, nuts, couplings and the like shall be coated after the joint has been made.

c. Painting shall be in accordance with Section 09 91 00, Painting.

d. Pipe and fittings that are to be encased in concrete shall not be painted.

2. Cement Lining:

a. Except as noted on Drawings, all ductile-iron pipe and fittings for potable water installations shall be furnished with a cement-mortar lining not less than twice the standard thickness and seal coating meeting the requirements of AWWA C104.

3. Glass Lining Pipe and Fittings

a. Glass lining, pipe and fittings shall consist of a minimum of two (2) glass lining coats, one bonded or primer coat and one finish or gloss coat.

1) Each coating shall be applied in controlled thickness after the inside surface of the pipe has been prepared as required to assure a continuous and unbroken bond of the coating to the pipe.

2) The combined, finished coatings shall have a thickness from 8 to 12 mils, and a surface hardness of at least 6 on the Mohs scale.

3) The bond of the glass lining to the metal shall be sufficient to withstand a strain of 0.001-in./in. without damage to the glass.

4) Surface of glass shall have a dense, glazed finish nonadherent to grease, scum, wax or other sticky substances found in sludge.

b. Ensure that firing of pipe and applied coating layers shall provide a complete fusion to the pipe wall.

1) The compounding, firing and annealing technique shall assure a lining capable of withstanding thermal shock up to 260 °F without damage to the surface or structure of the coating or to its bond with the pipe material.

c. Finish coating shall be free from craters, porosity, crazing, scaling, or pinholes evident from visual inspection.

1) Pipe need not meet a spark test for continuity, but will be rejected for any faults detectable by visual inspection.

d. Finish coating shall be resistant to attacks from acids equivalent to a weight loss not greater than 3 mg /in^2 as determined by the procedure for testing against citric acid, ASTM C283. The coating shall protect against etching or loss of gloss when subjected to cleaning procedures employing a 200°F water-steam mixture.

e. Glass-lined pipe shall not deviate more than 0.0125-in./ft of length from a centerline perpendicular to the flange face or square end of the pipe.

4. Exterior Primer:

a. Pipe and fittings shall be shop coated on the outside in accordance with Section 09 91 00, Painting, for use in exposed locations, such as inside buildings where finish painting or insulating is required.

5. Painting:

a. Pipe and fittings shall be painted in accordance with the requirements of Section 09 91 00, Painting.

6. Asphaltic Coating:

a. Pipe and fittings that will not be exposed to view shall be coated with the standard asphaltic outside coating specified in AWWA C151, at twice the specified thickness.

b. Unlined pipe shall be coated with the standard asphaltic inside coating specified in AWWA C151.

7. Epoxy and Urethane Coatings:

a. Epoxy and urethane coatings shall be applied in accordance with Section 09 91 00, Painting.

b. Protective Fusion – Bonded Coating in accordance with AWWA C116, Interior and Exterior Surface of Ductile Irion and Gray Iron-Fittings

c. Epoxy coatings and linings shall be in compliance with AWWA C213.

8. Concrete Encased Pipe:

a. Pipe and fittings which are to be encased in concrete where water-tightness is to be obtained shall not be coated or painted on the outside.

9. Labels:

a. In addition to the information required to be cast onto the pipe by AWWA C151, the letters "N.Y.C." shall be painted on the outside of each pipe, fitting, and special casting.

10. Pipe Couplings:

a. Where flexible or rigid couplings are to be used, the exterior coating on the ends of pipe and fittings shall be left off for approximately 8-in., but the interiors shall be lined throughout.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. The manufacturer shall have factories, including pipe mills, foundries, fabrication shops and machine shops, which hold a current ISO 9001Certificate of Quality System Registration. The Contractor shall furnish all documentation necessary to verify the manufacturer's certification and registration.

B. The Contractor shall furnish Work in new and unused condition. The Work shall include products and services from manufacturers having a successful record of manufacturing and servicing the materials specified herein for a minimum of 10 years prior to the bid opening for the Contract.

C. The Contractor and manufacturer shall perform and document all quality control (QC) and quality assurance (QA) procedures performed during manufacturing at the factory; during loading of the Work for transport at the factory; during transport to the Site; during unloading and storage of the Work at the Site; and during installation and startup at the Site, all as part of the Work specified herein.

D. The Contractor shall be responsible for coordinating QC and QA testing of Work, to be witnessed by the City, the Engineer and Resident Engineer in the factory, such that they may be conducted on consecutive days and completed during a single trip the Contractor shall notify the Engineer and Resident Engineer of scheduled factory QC and QA testing and inspections three weeks, at a minimum, prior to the first scheduled testing date.

E. The City, Engineer and Resident Engineer may perform independent testing of the Work, herein referred to as "QA verification", at any time during manufacturing at the factory; during loading for transport at the factory; during transport to the Site; during unloading and storage at the Site; and during installation and startup at the Site. DEP shall retain the services of an industry specialist and the Engineer to perform all QA verification procedures. The Contractor and manufacturer shall allow unhindered access to DEP representative(s), the Engineer and the Resident Engineer, including access for still and video photography of the Work.

F. QA Verification will include chemical analysis, examination, and testing as specified, following QA and QC procedures performed by the manufacturer and Contractor. The Contractor shall remove and replace, at no increase in Contract price or Contract time, all defective Work verified to be in noncompliance with acceptance criteria specified herein.

G. Where defective Work is identified and rejected, based on the QA verification analyses, inspections and testing performed by DEP, the Engineer or Resident Engineer on corrected Work shall be paid for by the Contractor. The Contractor shall provide airfare (direct flights), hotel, taxi and current per diem rates for the location of inspection within the U.S.A. by GSA region, and all incidental travel expenses for a DEP representative, the Engineer and the Resident Engineer.

H. In addition, reimbursement for subsequent QA verification inspections shall include all repeat QA verification analyses, testing and/or inspection related costs, including costs associated with the personnel travel expenses described herein; laboratory analysis; and repeat testing or inspection report review and analysis by DEP, the Engineer and Resident Engineer.

I. All products shall be designed, manufactured, delivered and installed in accordance with the requirements of specified herein. Products specified herein shall be new and unused products of manufacturers having a successful record of manufacturing and servicing the products specified herein for a minimum of 10 years.

J. The Contractor shall submit to the Engineer four copies of all certified mill test reports (MTRs) for chemical analysis, mechanical properties including tensile, impact, and bend test results for all materials used in the manufacture of products specified herein. MTRs shall identify the products for which the material will be used, and information necessary to verify compliance with the requirements specified herein.

K. If there are difficulties in operation of the systems included under this Contract due to defective Work under this Section, additional services performed by the Contractor and/or manufacturer, to correct the defective Work and meet the acceptance testing requirements shall be provided at no change in Contract price or Contract time.

L. Inspection by DEP, the Engineer or Resident Engineer or failure to inspect shall not relieve the Contractor of its responsibility to provide materials and perform the Work in accordance with the Contract Documents.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Damaged pipe will be rejected and shall be replaced at the Contractor's expense.

3.02 INSTALLATIONINSTALLATION

A. Install ductile iron and cast-iron pipes, fittings, and specials in accordance with the requirements of the following Reference Standard(s):

1. AWWA C600/M41 – Installation of Ductile-Iron Pipe.
2. AWWA C150 –Thickness Design of Ductile Iron Pipe

B. Pipe embedment shall be Type 5, were pipe bedded to its centerline in compacted granular material, 4 inch minimum under pipe. Compact granular or select material to top of pipe and compact to at least 90 percent Standard Proctor, as per AASHTO T99.

3.03 FIELD TESTING / QUALITY CONTROL

A. Perform field testing and quality control of ductile iron and cast iron pipe, fittings, and specials in accordance with the requirements of the following Section(s):

1. Section 33 05 05.30 - Leakage Testing for Buried Piping

3.04 STARTUP / DEMONSTRATION

A. All ductile iron pipe for potable water service shall be disinfected before they are placed into service and after cleaning, as specified in Section 33 01 10.60 - Disinfection of Piping, Tanks, Structures, and Equipment.

B. Provide all necessary equipment and labor for the disinfection and disposal of disinfection procedure waste.

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

NO TEXT ON THIS PAGE

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required, to furnish and install all components of the system for identification of exposed piping and equipment.

B. The following index of this Section is presented for convenience:

C. The following schedules, attached after the “End of Section” designation, are a part of this Section:

1. Schedule 40 05 97-1, Dimensions of Identification Signs and Nameplates.
2. Schedule 40 05 97-2, Table of Standard Colors.
3. Schedule 40 05 97-3, General Color Code.
4. Schedule 40 05 97-4, Pipe Identification Signs.
5. Schedule 40 05 97-5, Nameplates.
6. Schedule 40 05 97-6, Pipeline and Equipment Identification.

7. Schedule 40 05 97-7, Mixed Sludge and Digested Sludge Recirculation Pipeline and Equipment Identification.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

1.04 REFERENCES

A. ASTM D523 Standard Test Method for Specular Gloss

B. ASTM D543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

C. ASTM D638 Standard Test Method for Tensile Properties of Plastics

D. ASTM D646 Standard Test Method for Grammage of Paper and Paperboard (Mass per Unit Area)

E. ASTM D709 Standard Specification for Laminated Thermosetting Materials

F. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

G. ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

H. ASTM D5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)

I. SAE AMSSTD595 Colors Used in Government Procurement.

J. New York City Local Law 30 and New York State Building Code

1.05 DESCRIPTION

A. This Section describes the system for the identification of piping and equipment. This includes the placing of identification signs and direction-of-flow arrows on all visible, exposed plant piping, the placing of nameplates on plant equipment and structures, and painting in color of all equipment and pipe (except stainless steel or aluminum surfaces) as shown on the Contractor's Shop Drawings submitted under other Section(s) for equipment, piping, and valves, and as required.

1.06 QUALITY ASSURANCE

A. Provide the specified items from firms regularly engaged in the manufacture of identification devices of types and sizes required, with at least five (5) years' experience in manufacturing signs.

B.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited to:

1. Action Submittals:

a. Submit samples of the lettering to be used for fiberglass reinforced plastic signs to the Engineer for approval before manufacturing begins.

1) Such samples must show the height, width and spacing of letters and numbers for any three (3) legends of ten or more letters and spaces as specified herein.

b. Submit sample direction-of-flow arrows for both sizes of pipe identification signs to the Engineer for approval before installation.

c. Submit details of the method of fastening nameplates to the Engineer.

1) Since it is impractical to detail each means of attachment in the Contract Drawings, each means of attachment shall receive approval only on its own merits – submit for approval sketches of each type of attachment proposed.

2. Information Submittals:

a. Submit certification on acid resistance to the Engineer prior to installation.

b. Submit manufacturer's guarantee and warranty, in writing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Contractor shall provide spare parts and special tools necessary to service, disassemble, repair, and adjust the materials provided under this Section, and as per the requirements of the Contract Documents.

B. In addition, provide the following spare parts for identification of piping and equipment:

1. For every twenty (20) pipe identification signs installed:

a. One (1) pair stainless steel mounting screws

b. One (1) pair stainless steel threaded brackets

c. One (1) pair fiber or plastic washers

d. One (1) pair stainless steel banding seals

2. One (1) set banding tools and banding accessories

3. One (1) stainless steel banding strap, approximately 1000 ft.

4. One (1) complete nameplate mounting assembly for every twenty (20) nameplates installed

5. One (1) stainless steel cable and splice for every twenty (20) valve identification tags

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. All products provided under this Section shall be covered by a ten (10) year manufacturer warranty, which shall commence upon Substantial Completion, and shall cover the nameplates and signage against color fading, chipping, corroding or any other manufacturing defects.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mounting assembly "Steelbinder" strapping units:

1. A.J. Gerrard & Co., Lake City, FL;

2. Independent Metal Strap, Roslyn, NY;

3. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Construction:

1. Construct fiberglass reinforced plastic identification signs and nameplates of 100 mils thick fiberglass reinforced plastic conforming to ASTM D709.

2. Provide fiberglass reinforced plastic process with a blemish free, low gloss surface of superior permanence and durability in the colors selected.

3. Construct all signs and nameplates in conformity with ASTM D523, D638, D646, D790, D792, and D5420.

4. Make direction-of-flow arrows for attachment to pipe identification signs from No. 16 U.S. gauge Type 304 stainless steel, the full width of the sign.

5. Chemical Resistance:

a. Provide fiberglass reinforced plastic signs resistant to abrasion, impact, corrosion, and the following acids, alkalis, salts, and solvents in accordance with ASTM D543:

1) 10% citric acid

2) 5% acetic acid

3) 3-30% sulfuric acid

4) 10% ammonium hydroxide

5) 10% sodium chloride

6) turpentine

7) mineral spirits

8) heptane

9) kerosene

10) ethyl alcohol

11) ethyl acetate

12) transformer oil

13) heavy duty detergents

14) water

B. Lettering:

1. Provide lettering made by silk screening or other permanent embedment of subsurface printed graphics in the material so as to produce a clear, legible sign.

C. Grommets and Holes:

1. Provide signs for piping and valve identification with two ⅜-in. diameter grommet-protected holes located on the long side center line, the center of the hole to be ½-in. from the edge.

2. Provide nameplates for equipment and structures with four ⅜-in. diameter grommet-protected holes, the center of the hole located ½-in. away from the edges.

3. Provide all holes with suitable brass or stainless steel grommets.

4. Shall be of Type 304 stainless steel construction.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Dimensions of Signs and Tags:

1. Provide identification signs and nameplates rectangular in shape and of the dimensions specified in Schedule 40 05 97-1, Dimensions of Identification Signs and Nameplates, located after the "End of Section" designation.

    a. A dimensioned tolerance of $\pm 1/16$- in. is permissible.

B. Lettering of Signs:

1. Perform all lettering and numbering on identification signs and nameplates in block style in size and spacing to suit the size of sign, as approved by the Engineer.

2. Unless otherwise approved by the Engineer, the following limits shall apply:

    a. Limit the legend on pipe identification signs to one (1) line and to a total of 12 letters and spaces

    b. Limit the legend on equipment nameplates to two (2) lines and a maximum of 35 letters and spaces.

3. Do not place lettering, symbols or markings containing the name of the manufacturer on the signs.

    a. The contract number and the year of the contract as given on the Contract Drawings may be placed in small lettering on the front of the sign, if approved by the Engineer.

C. Colors:

1. Provide each identification sign and nameplate in two colors and with the legend specified.

    a. Provide the backside of the sign in black or some other uniform color.

2. Code pipeline signs and equipment nameplates and finish coats of paint for pipelines and equipment in basic colors.

3. Provide brilliant colors, distinctive shades matching as closely as possible (without custom color blending) the basic colors as specified by the Munsell Color System (MN) in Schedule 40 05 97-2, Table of Standard Colors, located after the "End of Section" designation:

4. Provide identification signs for pipelines of all sizes, mechanical equipment, sluice gates, and valves in the color combinations specified in Schedule 40 05 97-3, General Color Code, located after the "End of Section" designation.

5. Provide vents and drains of the same color combination as the contents of tanks and equipment vented and drained.

6. Identification signs for services not included in the Schedule 40 05 97-3 shall be black letters on a white background.

D. Legend for Pipe Identification Signs:

1. Provide identification signs, to identify the pipeline service, with the words or abbreviations in color combinations shown in Schedule 40 05 97-4, Pipe Identification Signs, located after the "End of Section" designation.

2. Number sluice gates and valves in conformity with the Basic Code as specified by the Operation and Maintenance Manual for the plant. Perform color combinations for such lines and valves in the same color combinations as the medium serviced and as specified in Schedule 40 05 97-3.

3. In addition to the identification requirements listed above, for all gas piping at pressures above ½ psig, show the maximum pressure level within the piping as required by New York City Local Law 30.

E. Valve Identification Tags:

1. Furnish and attach valve identification tags to all valves, gates, and controls.

2. Provide round fiberglass reinforced plastic discs tags, approximately 2-in. in diameter, made in conformity with the requirements specified herein. Provide tags with one ⅛-in. grommet protected hole at the top for fastening to the valve body using $^{1}/_{16}$-in. diameter cable and splices or pins as approved. Provide grommets, cable splices and pins of stainless steel or other approved corrosion resistant material.

3. Provide numbering code for the identification tags in conformity with the Basic Code as specified by the Operation and Maintenance Manual for the plant. Assign identification numbers subject to the approval of the Engineer and in conformity with the entire piping and equipment identification system. Provide identification code for each valve and control without duplication. Provide lettering on identification tags not less than $^{5}/_{16}$-in. high and limited to two lines. Silk-screen lettering in correct color combination; stenciled or painted numbers and lettering will not be accepted.

4. In addition to the tagging requirements listed above, provide tags at all gas valves at pressures above ½ psig with the operating pressure within the valve shown as required by New York City Local Law 30.

F. Arrows:

1. Make the arrow head with a tapered point, about 90° at the apex, extending one half of the sign width from the sign edge and one half of the sign width extending under the sign.

a. Make point with a radius of ¼-in. for the 3½-in. wide sign and a radius of $^{3}/_{16}$-in. for the 1½ in. wide sign.

2. Finish all edges of the arrow.

3. Punch detents on the arrows to prevent twisting of the point.

4. Drill one hole in the arrow in alignment with the hole in the pipe identification sign so that both sign and arrow can be mounted with the same screw and bracket.

G. Nameplates:

1. Provide nameplates for equipment and structures in the same color combination as the medium they service. Legends for nameplates must follow the terminology shown. Provide numbering system as described in the Operation and Maintenance Manual.

2. Schedule 40 05 97-5, Nameplates, located after the "End of Section" designation, is a representative list (and not necessarily complete) of nameplate legends with appropriate color combinations to which the equipment identification number(s) shall be added.

H. Additional Signs and Nameplates:

1. In addition to the legends specified above, the Engineer may order the Contractor to furnish and install additional identification signs, arrows and nameplates at no additional cost to the City.

2. Such additional signs may be requested near completion of the work and will be limited to no more than five (5) signs for each of the five (5) types listed in Schedule 40 05 97-1.

3. Conform legends and color combinations for additional signs to the requirements specified.

I. Color of Pipelines and Equipment:

1. Paint all pipelines and equipment in conformity with the requirements of Section 09 91 00 - Painting.

a. Color code the color of the final coats of paint.

2. Match the color of the final coats as closely as possible, without custom blending, to the colors presented in Schedule 40 05 97-6, Pipeline and Equipment Identification, located after the "End of Section" designation.

a. For mixed sludge and digester sludge recirculation pipelines and equipment, use Schedule 40 05 97-7, Mixed Sludge and Digested Sludge Recirculation Pipeline and Equipment Identification, located after the "End of Section" designation.

b. The colors in Schedule 40 05 97-6 and Schedule 40 05 97-7 are identified by a name and their SAE AMSSTD595 color identification number and shall match this standard; the names of the colors in Schedules 40 05 99-6 and 40 05 97-7 are for convenience only.

3. Do not paint aluminum or stainless steel ductwork or jackets on insulated pipelines. Should the Contract Documents state that flanges, flexible couplings, valves, and/or fittings for such jacketed lines not be covered, paint only the flanges, flexible couplings, valves, and/or fittings in accordance with the piping color code.

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Location:

1. Locate identification signs for piping along straight line runs at intervals of not more than 30 ft, near valves, branches and junction points and where pipes pass through walls or ceilings.
2. Place direction-of-flow arrows as shown or required.
3. Locate signs on large valves on or adjacent to the valve itself.
4. Place all piping identification signs so as to be easily visible from operating locations.
5. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures so as to prevent damage to the nameplate.

3.02 INSTALLATION

A. Mounting:

1. Mount identification signs and arrows on piping parallel and tangent to the pipe and valves by fastening with screws, plastic or fiber washers, threaded brackets, and banding straps and seals.
2. Provide screws and brackets of stainless steel with 5/16 - 18 American Standard Coarse Threads; provide No. 25 U.S. gauge stainless steel, 3/4 inch wide bands.
3. Where pipe is insulated, use care in mounting the signs so to prevent the banding straps from crushing the insulation.
4. Provide mounting assembly "Steelbinder" strapping units.
5. Mount nameplates in the manner specifically approved by the Engineer, after the installation of equipment or the construction of structures is complete.

6. Mount valve identification signs with approved stainless steel brackets or approved stainless steel strapping in such a fashion that sharp corners or edges on signs, brackets, bolts, chain or strapping will not constitute a hazard to personnel operating the valves.

7. Do not attach identification tags or signs to handwheels.

8. Use of flange bolts or bonnet bolts as a means of attachment of brackets shall receive consideration by the Engineer.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SCHEDULE 40 05 97-1
DIMENSIONS OF IDENTIFICATION SIGNS AND NAMEPLATES

Type of Sign:	**Sign Dimensions: (Width × Length)**
PIPE IDENTIFICATION -	
1. Outside diameter of pipe (including pipe insulation):	
a. 4-in. and larger:	3½-in. × 12-in.
b. Less than 4-in.:	1½-in. × 7-in.
VALVE IDENTIFICATION -	
1. Valve tags:	2-in. diameter
2. Operating stands for valves and sluice gates:	1½-in. × 7-in.
NAMEPLATES -	
1. Equipment and structures	3½-in. x 12 in.

SCHEDULE 40 05 97-2
TABLE OF STANDARD COLORS

Color:	**Munsell Number:**
White	MN - N8.8/
Yellow	MN - 4Y7.5/12.8
Orange	MN - 0.5 YR 4.6/12.2
Red	MN - 7R 3.6/12.7
Brown	MN - 2.5 YR 4.2/4.3
Gray	MN - 2.5PB 5.8/1.7
*Charcoal	MN - 6B 5/0.4
Black	MN - N1/
Blue	MN - 3PB 3.3/7.4
Green	MN - 8G 4.4/6.2
* Provide color "Charcoal" for paints equivalent to MN - N 3.75.	

SCHEDULE 40 05 97-3
GENERAL COLOR CODE

Service Line:	**Colors:**	
	Letters:	**Background:**
1. FIRE AND STANDPIPE	White	Red
2. SLUDGE OR UTILITY GAS		
a. High Pressure	Black	Orange
b. Low Pressure	White	Orange
3. FUEL OIL	Orange	White
4. LUBRICATING OIL	Black	White
5. HYDRAULIC FLUID	Red	White
6. CHEMICALS		
a. Ferric Chloride	White	Blue
b. Glycerol	Brown	Yellow
c. Methanol	Black	Yellow
d. Polymer	Brown	Yellow
e. Sodium Bisulfite	Orange	Black
f. Sodium Hydroxide	Black	Yellow
g. Sodium Hypochlorite	Blue	Yellow
h. Other (Hazardous)	Black	Yellow
i. Other (Relatively Safe)	Brown	Yellow
7. OZONE	Black	Yellow
8. CHLORINE		
a. Gas	Black	Yellow
b. Liquefied	Red	Yellow
c. Solution	Blue	Yellow
9. LIQUIDS THICK IN SOLIDS	White	Black
a. Primary Sludge		

Service Line:	Colors:	
	Letters:	Background:
b. Digested Sludge c. Thickened Sludge		
10. LIQUIDS THINNER IN SOLIDS a. Secondary Sludge b. Return Sludge c. Mixed Liquor d. Grease, Scum, Grit	White	Brown
11. LIQUIDS WEAK IN SOLIDS a. Sewage b. Effluent c. Thickening Tank Drains, Vents, Overflow d. Digester Tank Drains, Vents, Overflow e. Concentration Tank Drains, Vents, Overflow f. Storage Tank Overflow, Drains g. Settling Tank Overflow, Drains h. Sump Drains	Black	Gray
12. STRAINED EFFLUENT a. Spray Water b. Flushing Water c. Plant Water	Yellow	Gray
13. NON-POTABLE WATER a. Seal Water b. Chilled Water c. Engine Cooling Water d. Sludge Heating Water e. Hydraulic Control Water	Yellow	Blue

Service Line:	Colors:	
	Letters:	Background:
14. CITY WATER	White	Blue
15. STEAM, DANGEROUSLY HOT WATER	Blue	Orange
16. ENGINE AIR		
a. Starting	Orange	Green
b. Intake	Yellow	Green
17. ENGINE EXHAUST	Yellow	Orange
18. VACUUM SERVICE	Black	Green
19. PLANT SERVICE (COMPRESSED) AIR	White	Green
20. PROCESS (BLOWER) AIR	Gray	Green
21. HIGH PRESSURE AIR	Orange	Green
22. HEATING, VENTILATING AND CONDITIONING AIR (Equipment And Ductwork)	Green	Charcoal

SCHEDULE 40 05 97-4
PIPE IDENTIFICATION SIGNS

Legend:	**Service:**	**Color Code:**	
		Lettering:	**Background:**
BLOWER LUBE	Blower lube oil	Black	White
BLOWOFF	Blowoff	*	*
CAUSTIC	Caustic soda (Sodium hydroxide)	Black	Yellow
CHILL SUPPLY	Chilled water supply	Yellow	Blue
CHILL RETURN	Chilled water return	Yellow	Blue
CHLORINE GAS	Chlorine gas	Black	Yellow
CHLOR. LIQ.	Liquefied chlorine	Red	Yellow
CHLOR. SOL.	Chlorine solution	Blue	Yellow
COMP. AIR	Compressed or plant service air	White	Green
CONDENSATE	Condensate	Yellow	Blue
DEFOAMANT	Defoamant or foam control	Brown	Yellow
DIESEL FUEL	Diesel fuel oil	Orange	White
DIGEST. SL.	Digested sludge	White	Black
DIG. O'FLOW	Digester overflow	Black	Gray
DISINFECT	Disinfectant	Brown	Yellow
DRAIN - *	Drain - *	*	*
EFFLUENT	Effluent water	Black	Gray
ENGINE AIR	Engine air intake	Yellow	Green
ENG. EXHAUST	Engine exhaust	Yellow	Orange
ENGINE LUBE	Engine lube oil	Black	White

Legend:	Service:	Color Code:	
		Lettering:	Background:
ENGINE VENT	Engine crankcase vent	Black	White
EXCESS SLUDGE	Excess sludge	White	Black
EXH. BLOWOFF	Exhaust silencer blowoff	Red	Blue
FERRIC	Ferric chloride	White	Blue
FIRE	Fire line	White	Red
FLUSH. WATER	Pump flushing water	Yellow	Gray
FLY ASH	Wet fly ash	White	Black
FUEL OIL	Fuel oil	Orange	White
FUEL FILL	Fuel oil fill	Orange	White
GAS – SLUDGE	Sludge gas	White	Orange
GAS – UTILITY	Utility gas	White	Orange
GAS – HP	Sludge or utility gas – high pressure	Black	Orange
GLY	Glycerol	Brown	Yellow
GREASE	Grease	White	Brown
GRIT	Grit	White	Brown
HI PRESS. AIR	High pressure air	Orange	Green
H.W. RETURN	Hot water return	Blue	Orange
H.W. SUPPLY	Hot water supply	Blue	Orange
HYDRAULIC	Hydraulic fluid	Red	White
HYPOCHLORITE	Sodium hypochlorite	Blue	Yellow
INSTR. AIR	Instrument air	White	Green
JACKET WATER	Engine jacket water	Yellow	Blue

Legend:	Service:	Color Code:	
		Lettering:	Background:
LUBE	Lubricating oil	Black	White
LUBE FILL	Lubricating oil fill	Black	White
METER - *	Metering - *	*	*
METHANOL	Methanol	Black	Yellow
MIXED LIQUOR	Mixed liquor	White	Brown
MIXED SLUDGE	Mixed sludge	White	Brown
MODIFIED SL.	Modified sludge	White	Brown
O'FLOW - *	Overflow - *	*	*
OZONE	Ozone	Black	Yellow
PLANT DRAIN	Plant drain	Black	Gray
PLANT WATER	Plant water	Yellow	Gray
POLYMER	Polymer	Brown	Yellow
PRIMARY SL.	Primary sludge	White	Black
PROCESS AIR	Process or blower air	Gray	Green
RECIRC. SL.	Recirculated sludge	White	Brown
RETURN SL.	Return sludge	White	Brown
SBS	Sodium bisulfite	Orange	Black
SCUM	Scum	White	Brown
SEAL WATER	Seal water	Yellow	Blue
SECOND. SL.	Secondary sludge	White	Brown
SEWAGE	Sewage	Black	Gray
SEW. SAMPLE	Sewage sampling	Black	Gray
SPRAY WATER	Spray water	Yellow	Gray

Legend:	Service:	Color Code:	
		Lettering:	Background:
STARTING AIR	Starting air	Orange	Green
STEAM	Steam	Blue	Orange
SUMP - *	Sump pump line - *	*	*
SUPERNATANT	Supernatant	Black	Gray
THICK. DR.	Thickener drain	Black	Gray
THICK. EFF.	Thickener effluent	Black	Gray
THICK. SL.	Thickened sludge	White	Black
TREAT. WATER	Chemically treated boiler feed water	Brown	Yellow
VACUUM	Vacuum line	Black	Green
VENT - *	Vent - *	*	*
WASTE GAS	Waste gas	White	Orange
WASTE OIL	Waste lubricating oil	Black	White
WATER	City water	White	Blue
* Where shown, specified or required, the legend for blowoff, drain, metering, sump, vent and similar lines shall also include the equipment, structure or identification number to which the service applies.			

SCHEDULE 40 05 97-5
NAMEPLATES

Legend:		**Color Code:**	
First Line(1):	**Second Line(2):**	**Lettering:**	**Background:**
AIR BLOWER	**	White	Charcoal
AIR COMPRESSOR	**	White	Green
AIR HANDLING	UNIT **	White	Charcoal
AIR CONDITIONING	UNIT **	White	Charcoal
AUXILIARY ELECTRIC	GENERATOR **	Red	Green
AUXILIARY LUBE	OIL PUMP **	Black	White
BAR SCREEN	**	Black	Gray
BLOWER CONTROL	CABINET **	Gray	Green
BLOWER CONTROL AIR	RECEIVER **	White	Green
BLOWER LUBE OIL	AUX. PUMP **	Black	White
BLOWER LUBE OIL	COOLER **	Black	White
BLOWER LUBE OIL	RESERVOIR **	Black	White
BLOWER SILENCER	**	Gray	Green
BULK LUBE OIL	STORAGE **	Black	White
BYPASS OIL FILTER	**	Black	White
CHILLERS	**	White	Blue
CLEAN LUBE OIL	TANK **	Black	White
CONCENTRATION TANK	**	White	Black
CONDENSATE PUMP	**	Yellow	Blue
CONDENSATE RECEIVER	**	Yellow	Blue
CONDENSER	WATER COOLED **	Yellow*	Blue*
CONDENSER	AIR COOLED **	Yellow*	Blue*
CONE VALVE AIR	RECEIVER **	White	Green
DESCALER	**	Yellow	Blue

Legend:		Color Code:	
First Line(1):	**Second Line(2):**	**Lettering:**	**Background:**
DIESEL TANK	**	Orange	White
DIGESTION TANK	**	White	Black
DIRTY LUBE OIL	TANK **	Black	White
EFFLUENT-LUBE OIL	COOLER **	Yellow	Gray
EFFLUENT WATER	STRAINER **	Yellow	Gray
EFFLUENT WATER	PUMP **	Black	Gray
EFFLUENT WATER	TANK **	Yellow	Gray
ENGINE GENERATOR	**	Red	Green
ENGINE J.W.	MAKEUP	Yellow	Blue
ENGINE LUBE OIL	PURIFIER **	Black	White
ENGINE LUBE OIL	TANK **	Black	White
ENGINE OIL SUMP	TANK **	Black	White
EXHAUST FAN	**	White	Charcoal
EXCESS SLUDGE	DISTRIB. BOX **	White	Black
EXHAUST STEAM	CONVERTER **	Blue	Orange
FAN COIL UNITS	**	Blue*	Orange*
FLUSHING WATER	PUMP **	Yellow	Gray
FUEL OIL	PUMP **	Orange	White
FUEL OIL TANK	NO. 2 OIL **	Orange	White
FUEL OIL TANK	NO. 4 OIL **	Orange	White
FUEL OIL TANK	NO. 6 OIL **	Orange	White
FULL FLOW OIL	FILTER **	Black	White
GAS BOOSTER	**	Black	Orange
GASOLINE TANK	**	Orange	White
GAS COMPRESSOR	**	Black	Orange
GAS RECEIVER	**	Black	Orange
GAS SURGE TANK	**	White	Orange
HEAT EXCHANGER	OIL **	White	Orange

Legend:		**Color Code:**	
First Line(1):	**Second Line(2):**	**Lettering:**	**Background:**
HEAT EXCHANGER	STEAM-WATER **	Blue	Orange
HEAT EXCHANGER	WATER-WATER **	Blue	Orange
HEAT RECOVERY	SILENCER **	Yellow	Orange
HEAT. & VENT.	UNIT **	White	Charcoal
HIGH PRESSURE AIR	COMPRESSOR **	Orange	Green
HIGH PRESSURE AIR	DRYER **	Orange	Green
HIGH PRESSURE AIR	RECEIVER	Orange	Green
HOT WATER BOILER	**	Blue	Orange
HOT WATER CONVERTER	DOMESTIC **	Blue	Orange
HOT WATER HEATER	ELECTRIC **	Blue	Orange
HOT WATER GENERATOR	DOMESTIC **	Blue	Orange
HYDRO-PNEUMATIC	TANK **	White	Blue
INLET SLUICE GATE	CYLINDER **	Red	White
JACKET WATER CIRC.	PUMP **	Yellow	Blue
JACKET WATER	COOLER **	Yellow	Blue
JACKET WATER ENG.	OIL COOLER **	Yellow	Blue
LUBE OIL	PURIFIER **	Black	White
LUBE OIL STORAGE	PUMP **	Black	White
LUBE OIL STORAGE	TANK **	Black	White
LUBE OIL TRANSFER	PUMP **	Black	White
MIXED SLUDGE	PUMP **	White	Brown
OUTLET SLUICE GATE	CYLINDER **	Red	White
OZONATOR	**	Black	Yellow
PLANT AIR	AFTERCOOLER **	White	Green
PLANT AIR	COMPRESSOR **	White	Green
PLANT AIR	RECEIVER **	White	Green

Legend:		Color Code:	
First Line(1):	**Second Line(2):**	**Lettering:**	**Background:**
PLANT WATER	MAKEUP **	Yellow	Gray
PLANT WATER	TANK **	Yellow	Gray
PLANT WATER	PUMP **	Yellow	Gray
PUMP – CHILLED WATER	**	White	Blue
PUMP – CONDENSER WATER	**	Yellow	Blue
PUMP – DOMESTIC	HOT WATER **	White	Blue
PUMP – FEED WATER	**	Yellow	Blue
PUMP – FIRE	**	White	Red
RETURN FAN	**	White	Charcoal
RETURN SLUDGE	PUMP **	White	Brown
SCUM PIT	**	White	Brown
SEAL WATER	PUMP **	Yellow	Blue
SEWAGE EJECTOR	**	Black	Gray
SEWAGE FLOW	METER **	Black	Gray
SEWAGE PUMP	**	Black	Gray
SLUICE GATE CONT.	AIR CHAMBER **	White	Green
SLUICE GATE CONT.	AIR TANK **	White	Green
SLUICE GATE HYD.	FLUID PUMP **	Red	White
SLUDGE HEATER	**	White	Black
SLUDGE HEATING H.W.	CIRC. PUMP **	White	Orange
SLUDGE HEAT WATER	MAKEUP TANK **	Yellow	Blue
SLUDGE DOCK	PUMP **	White	Black
SLUDGE RECIRC.	PUMP **	White	Brown
SLUDGE STORAGE	TANK **	White	Black
SLUDGE TRANSFER	BOX **	White	Black
SLUDGE TRANSFER	PUMP **	White	Black
SPRAY WATER	PUMP **	Yellow	Gray

Legend:		**Color Code:**	
First Line(1):	**Second Line(2):**	**Lettering:**	**Background:**
STANDBY GENERATOR	**	Red	Green
STARTING AIR	COMPRESSOR **	Orange	Green
STARTING AIR	TANK **	Orange	Green
STEAM BOILER	**	Blue	Orange
SUMP PUMP	**	Black	Gray
SUMP PUMP – CONC.	TANK **	Black	Gray
SUMP PUMP – DIGEST.	TANK **	Black	Gray
SUMP PUMP – EFF.	VAULT **	Black	Gray
SUPPLY FAN	**	White	Charcoal
THICKENER	**	White	Black
TRASH RACK	**	Black	Gray
UNIT HEATER – STEAM	**	White*	Charcoal*
UNIT HEATER – WATER	**	White	Charcoal*
WASTE LUBE OIL	PUMP **	Black	White
WASTE LUBE OIL	TANK **	Black	White
WATER TREATMENT	PUMP **	Brown	Yellow
WATER TREATMENT	TANK **	Brown	Yellow

(1) Nominal limit of 18 letters, numerals and spaces.
(2) Nominal limit of 17 letters, numerals and spaces.

*Where equipment is mounted on roofs or where exposed to the public view, such as in lobby or office areas, the color will be selected by the Architect.

**The legend on these nameplates also includes the appropriate six-digit numeral and letter designation for such equipment and structures as specified by the Operation and Maintenance Manual.

SCHEDULE 40 05 97-6
PIPELINE AND EQUIPMENT IDENTIFICATION

Abbr.:	Process/Service Line:	Fed. Std. 595B Color:
AD	Aerator Drain	Gray 16187
APLM	Anionic Polymer	Green 14090
BLW	Balance Water	Blue 15193
BLO	Blower Lube Oil	White 17925
CPLM	Cationic Polymer	Green 14090
CSTC	Caustic (Sodium Hydroxide)	Orange 22544
CEN	Centrate	Gray 16492
CF	Centrifuge Feed	Black 14036
CHA	Channel Air	Green 14260
CHWR	Chill Water Return	Blue 17877
CHWS	Chill Water Supply	Blue 15450
CHEFF	Chlorinated Effluent	Gray 17875
CW	City Water	Blue 15200
CLD	Clarifier Drain	Gray 16187
CLWR	Cold Water Return	Blue 15187
CLWS	Cold Water Supply	Blue 15125
CA	Compressed Air (Plant Air)	Green 14449
CCSK	Concentrated Skimmings	Tan 17778
CSB	Concentrator Subnatant	Gray 16314
C	Condensate	Gray 16357
CTD	Contact Tank Drain	Gray 16187
DFM	Defoamant	Pink 11630
DGOF	Degrit Overflow	Gray 16250
DGS	Degritted Primary Sludge	Olive 14257
DWS	Dewatered Sludge	Navy 15044
DF	Diesel Fuel	Mustard 13275

Abbr.:	Process/Service Line:	Fed. Std. 595B Color:
DSD	Digested Sludge Disposal	Brown-black 10032
RCD	Digested Sludge Recirculation (mixing)	(See Note 1)
DSR	Digested Sludge Recycle	Black 14084
DSS	Digested Sludge to Storage	Black 17038
DST	Digested Sludge Transfer	Gray 16081
DSK	Dilute Skimmings	Tan 16405
ELF	Elutriation Feed	Black 15042
ECWR	Engine Cooling Water Return	Gray 15526
ECWS	Engine Cooling Water Supply	Navy 15045
EXH	Engine Exhaust	Stainless Steel Jacket
ELO	Engine Lube Oil	White 17925
FECL	Ferric Chloride	Blue 15095
FEF	Final Effluent	Gray 16492
FRS	Fire and Standpipe	Red 11350
FW	Flushing Water	Blue 15090
FF	Fuel Fill	Tan 10266
FO	Fuel Oil	Brown 16160
	Gasoline Fill Port – high octane	Red 11086
	Gasoline Fill Port – middle octane	Blue 15056
	Gasoline Fill Port – low octane	White 17925
	Gasoline Fill Port, unleaded – high octane	Red 11086 with white 17925 cross
	Gasoline Fill Port, unleaded – middle octane	Blue 15056 with white 17925 cross
	Gasoline Fill Port, unleaded – low octane	White 17925 with black 17038 cross
	Gasoline Vapor Recovery	Orange 12246
GRIT	Grit	Gray 14064
HPAR	High Pressure Air (Plant Air)	Green 14272

Abbr.:	Process/Service Line:	Fed. Std. 595B Color:
DG(H)	High Pressure Digester Gas	Orange 22510
HPUGS	High Pressure Utility Gas	Orange 22510
HWR	Hot Water Return (heating)	Orange 12215
HWS	Hot Water Supply (heating)	Orange 11400
HVACEX	HVAC Exhaust	Gray 14158
HVACR	HVAC Return	Gray 14077
HVACS	HVAC Supply	Gray 14056
HCW	Hydraulic Control Water	Blue 15107
HOR	Hydraulic Oil Return	Brown 10059
HOS	Hydraulic Oil Supply	Brown 10045
ITK	Intake (Engine Air)	Green 14672
JKWR	Jacket Water Return	Gray 15109
JKWS	Jacket Water Supply	Navy 15050
	Kerosene Fill Port	Brown 20100
LM	Lime	Tan 13740
DG(L)	Low Pressure Digester Gas	Orange 22510
LPUGS	Low Pressure Utility Gas	Orange 22510
LF	Lube Fill	White 17925
MH	Methanol	Brown 10233
MS	Mixed Sludge (heating)	(See Schedule 40 05 97-7)
ODCDW	Odor Control Draw	Green 14110
ODCVT	Odor Control Vent	Unpainted
O2	Oxygen	Red 11105
OZR	Ozone Recycle	Blue 15177
OZS	Ozone Supply	Blue 15080
OZVT	Ozone Vent	Blue 15180
PD	Plant Drain	Gray 16187

Abbr.:	Process/Service Line:	Fed. Std. 595B Color:
PW	Plant Water	Blue 15092
PTPM	Potassium Permanganate	Red 11140
PEFF	Primary Effluent	Gray 16251
PA	Process Air	Green 14115
RINF	Raw Influent	Gray 16293
RPS	Raw Primary Sludge	Olive 14151
RSC	Raw Screenings	Tan 16350
RAS	Return Activated Sludge	Tan 10260
SMP	Sampling Line	(Match to Service)
SLW	Seal Water	Blue 15182
SBP	Secondary Bypass	Gray 16473
SAR	Service Air (Plant Air)	Green 14193
SW	Service Water	Blue 15102
SHW	Sludge Heating Water	Orange 12473
NA2SO3	Sodium Bisulfite	Black 14084
NAOCL	Sodium Hypochlorite	Yellow 13591
SPW	Spray Water	Navy 15052
STA	Starting Air (Engine Air)	Green 14187
STMR	Steam Return (Condensate)	Tan 11670
STMS	Steam Supply	Orange 22356
STD	Storm Drain	Gray 16440
SULAD	Sulfuric Acid	Brown 10049
SD	Sump Drain	Gray 16376
SU	Supernatant	Gray 16307
TS	Thickened Sludge	Brown 10070
TD	Thickener Drain	Gray 16187
TO	Thickener Overflow	Gray 16329

Abbr.:	Process/Service Line:	Fed. Std. 595B Color:
VCS	Vacuum Service	Green 14062
WAS	Waste Activated Sludge	Tan 13596
WDGS	Waste Digester Gas	Orange 22510
WML	Waste Mixed Liquor	Tan 12648
WO	Waste Oil	White 17925
WSC	Washed/Compacted Screenings	Black 14084

SCHEDULE 40 05 97-7

MIXED SLUDGE AND DIGESTED SLUDGE RECIRCULATION PIPELINE AND EQUIPMENT IDENTIFICATION

Digester No.:	**Color:**	**Digester No.:**	**Color:**
1	13531	5	10219
2	13522	6	10115
3	10324	7	10080
4	10371	8	10055

PART 1 GENERAL

1.01 SUMMARY

A. Contractor shall provide all labor, materials, equipment, incidentals, and appurtenances as shown, specified and required, to furnish, install, and test all exposed piping as indicated in the exposed piping schedule, complete and operational.

B. The following index of this Section is presented for convenience:

C.

A. The following schedule(s), attached after the end of section designation, are a part of this Section:

1. Schedule 40 06 01-1, Schedule of Exposed Piping.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 22 11 16 – Domestic Water Piping.

B. Section 22 11 19 – Domestic Water Piping Specialties.

C. 40 05 05 – Exposed Piping Installation

D. 40 05 06 – Couplings, Adapters, and Specials for Piping

E. 40 05 07 – Hangers and Supports for Process Piping

F. 40 05 19 – Ductile Iron and Cast Iron Pipe

G. 40 42 13 – Process Piping Insulation

1.04 REFERENCES

A. Not Used

1.05 DESCRIPTION

A. Not Used

1.06 QUALITY ASSURANCE

A. Not Used

1.07 SUBMITTALS

A. Not Used

1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Not Used

2.02 MATERIALS / EQUIPMENT

A. Not Used

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Not Used

3.02 INSTALLATION

A. Not Used

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

END OF SECTION

SCHEDULE 40 06 01-1
INTERIOR AND EXPOSED PIPING SCHEDULE

Service Name	Material	Wall Thickness/ Schedule/ Class	Type of Joint	Working Pressure (psig)	Test Type	Test Pressure (psig)	Interior Coating	Exterior Coatings, Treatments	Remarks
Kensico Site Electrical Building Sanitary Sewer & Vent Piping	CIP	Extra Heavy	NH	N/A	Hyd	9	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
Kensico Site Potable Water - Electrical Building	Cu	Type L	Brz	140	Hyd	200	N/A	N/A	Testing shall meet the requirements for the Code of the Town of Mount Pleasant Section 157-123
Kensico Site Clean Agent System - Electrical Building	GS	Schedule 40	Thd/GEC	600	Air	40	Gal	Gal	Testing shall meet the requirements of NFPA 2001.

A. The following service abbreviations are used in Schedule 40 06 01-1: Not Used

B. The following pipe material abbreviations are used in Schedule 40 06 01-1:

Pipe Material:	Abbrev:	Pipe Material:	Abbrev:
304L Stainless Steel	304L SS	Ductile Iron	DI
316L Stainless Steel	316L SS	Fiber-Reinforced Plastic	FRP
Black Steel	BS	Galvanized Steel	GS
Brass	Brass	High Density Polyethylene	HDPE
Carbon Steel	CS	Polytetrafluoroethylene	PTFE
Cast Iron Pipe	CIP	Stainless Steel	SS
Copper	Cu		

C. The following joint type abbreviations are used in Schedule 40 06 01-1:

Joint Type:	Abbrev:	Joint Type:	Abbrev:
Bell and Spigot	BS	Push-on Joint	POJ
Brazed	Brz	Shouldered End Coupling	SEC
Butt Weld	BW	Split-sleeve Coupling	SSC
Flanged	Flg	Soldered	Sld
Grooved End Coupling	GEC	Restrained Mechanical Joint	RMJ
Grooved / Shouldered End Coupling	GSEC	Restrained Push-on Joint	RPOJ
Lap Welded	LW	Threaded	Thd
Mechanical Joint	MJ	Welded	Wld
No-Hub Coupling	NH		

D. The following interior coating abbreviations are used in Schedule 40 06 01-1:

Interior Coating	Abbrev:	Interior Coating:	Abbrev:
Asphalt Coated	AC	EPDM (M-class) Rubber	EPDM
Basalt Coated	BC	Galvanized	Galv
Ceramic Epoxy Coated	CEC	Glass Lined	GL
Ceramic Epoxy Lined	CEL	Polyethylene Lined	PEL
Cement Lined	CL		

E. The following exterior coating and treatment abbreviations are used in Schedule 40 06 01-1:

Exterior Coating, Treat.:	Abbrev:	Exterior Coating, Treat.:	Abbrev:
Asphalt Coated	AC	Galvanized	Galv
Epoxy	Epx	Insulate	I

Heat Trace	HT	Paint	P

F. The following testing abbreviations are used in Schedule 40 06 01-1:

Test Type:	**Abbrev:**	**Test Type.:**	**Abbrev:**
Hydrostatic	Hyd	Air	Air

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, and test all insulation and jacketing for process piping systems, including piping, valves, and accessories, complete and operational.

B. The following index of this Section is presented for convenience:

C. The following schedule(s), attached after the end of section designation, are a part of this Section:

1. Schedule 40 42 13-1, Process Piping Insulation and Jacketing Schedule.

1.02 PAYMENT

A. No separate payment shall be made for performing any Work required under this Section. All costs for Work required by this Section shall be included in the applicable lump sum, unit price(s) or allowance(s) as set forth in Section 01 27 00 – Measurement and Payment.

1.03 RELATED SECTIONS

A. Section 09 91 00 – Painting

B. Section 40 05 07 – Hangers and Supports for Process Piping.

C. Section 40 06 01 – Schedule for Exposed Piping.

1.04 REFERENCES

A. Referenced Standards:

1.	ANSI B16.9	Standard for Factory Made Wrought Steel Butt Welding Fittings.
2.	ASTM C240	Standard Test Methods of Testing Cellular Glass Insulation Block.
3.	ASTM C411	Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
4.	ASTM C534	Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
5.	ASTM C552	Standard Specification for Cellular Glass Thermal Insulation.
6.	ASTM C547	Standard Specification for Mineral Fiber Pipe Insulation
7.	ASTM C1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
8.	ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber.
9.	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials.
10.	ASTM E96	Standard Test Method for Water Vapor Transmission of Materials.
11.	NFPA255	Surface Burning Characteristics of Building Materials.

12. Building Code of the State of New York.

13. New York State Energy Conservation Code.

1.05 DESCRIPTION

A. This Section includes requirements for providing insulation and jacketing for process pipe, valves, and accessories in accordance with applicable standards and regulations. In addition:

1. This Section also includes requirements for providing insulation and jacketing for HVAC and Plumbing System piping.

2. Refer to Schedule 40 42 13-1, Process Piping Insulation and Jacketing Schedule, for the extent of piping insulation and jacketing.

1.06 QUALITY ASSURANCE

A. Qualifications of Manufacturers:

1. The manufacturer(s) shall have a minimum of five (5) years of experience in the manufacture of process piping insulation products of similar size and type to those specified herein, and shall show evidence of at least five (5) substantially similar installations in satisfactory operation.

B. Supply and Compatibility:

1. Qualifications of Installer:

a. Use a single firm with at least five (5) years of successful installation experience on projects with insulation similar to that required for this Project.

2. The process pipe insulation and jacketing shall be fabricated and installed in accordance with the standards referenced herein.

3. The installer shall bear responsibility for the quality of all process pipe insulation and jacketing, regardless of the location of application.

4. The installer shall verify compatibility between the process pipe insulation and jacketing, and other Work.

C. Regulatory Requirements:

1. Process pipe insulation and jacketing shall conform to the New York City Building Code in respect to plumbing and other applications covered by these codes.

2. Flame/Smoke Ratings:

a. Piping insulation shall have a composite (insulation, jackets, coverings, sealers, mastics and adhesives) flame-spread index of 25 or less, fuel-contributed rating of 50 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA255) method.

b. Any treatments of jackets or facings to impart flame and smoke safety shall be permanent.

c. The use of water-soluble treatments shall be prohibited.

3. Building Code Compliance:

a. Process piping insulation and jacketing shall comply with the New York City Building Code and with the New York State Energy Conservation Code.

1.07 SUBMITTALS

A. Submittals shall comply with the requirements of the Contract Documents. In addition, submittals shall include, but not be limited, to:

1. Action Submittals:

a. Product Data: For each type of piping insulation (and related materials) that shall be installed as part of the Work, submit the following:

1) Technical product data;

2) Insulation materials;

3) Densities;

4) Fire ratings;

5) Flame-spread ratings;

6) Smoke-developed ratings;

7) Fuel contributed ratings;

8) Material safety data sheets; and

9) Installation instructions.

b. Schedule: For each individual piping system requiring insulation as specified in Schedule 40 42 13-1, Process Piping Insulation and Jacketing Schedule, submit a schedule including the following:

1) Insulation type (e.g., Type A, etc.) as specified herein;

2) Manufacturer name;

3) Product number;

4) K-value;

5) Thickness; and

6) Furnished accessories.

c. Stainless Steel Jacketing:

1) Submit the manufacturer technical data for all jacketing and related materials.

d. Installation Drawings: for each individual piping system requiring insulation as per Schedule 40 42 13-1, Process Piping Insulation and

Jacketing Schedule, submit complete installation drawings including:

1) Assembly and installation details;

2) Layout, including plan and section views;

3) Details for installation at valves and appurtenances;

4) All drawings and details shall have clearly marked dimensions, distances, offsets, and an arrow indicating north;

5) Callouts showing the type of installation as specified herein;

6) Callouts indicating stainless steel jacketing (if applicable);

7) Clear demarcation of the extents of insulation, as well as the extents of stainless steel jacketing (if applicable);

8) Critical clearance distances with insulation and jacketing installed. Clearances shall be to other, nearby and potentially conflicting pipelines, appurtenances, and structures, as shown on the Contract Drawings; and

9) Details for jointing insulation (and if applicable, stainless steel jacketing) butt joints and longitudinal seam.

2. Information Submittals:

a. Manufacturer instructions for handling, storing, installing, and adjusting of products.

b. Qualifications of process piping insulation installer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver materials provided under this Section in accordance with the requirements of the Contract Documents.

B. The Contractor shall store and handle materials provided under this Section in accordance with the requirements of the Contract Documents. In addition:

1. Protect the insulation against dirt, water, and chemical and mechanical damage.

2. Remove damaged materials from the project site.

1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Style “A” Insulation:

1. Johns Manville Corp., Denver, CO;
2. Owens Corning Co., Toledo, OH;
3. Or approved equal.

B. Style “B “Insulation:

1. NH Armaflex as manufactured by Armacell® LLC, Chapel Hill, NC;
2. Or approved equal.

C. Style C Insulation:

1. Pittsburgh Corning Corp., Port Allegany, PA;
2. Or approved equal.

D. Style D Insulation:

1. Johns Manville Corp., Denver, CO;
2. Owens Corning Company, Toledo, OH;
3. Or approved equal.

E. Stainless Steel Jacketing:

1. Z-lock Metal Jacketing, as manufactured by GLT Products®, Solon, OH;
2. Or approved equal.

F. Thermal Hanger Shields:

1. Pipe Shields Inc., Fairfield, CA;
2. Or approved equal.

G. Gypsum Cement Molding Plaster:

1. Hydrocal® B-11, as manufactured by U. S. Gypsum Corp., Chicago, IL;
2. Or approved equal.

2.02 MATERIALS / EQUIPMENT

A. Style “A” Insulation – Molded Fiberglass Pipe Insulation:

1. General:

a. Insulation shall be heavy-duty, bonded fibrous glass sectional pipe insulation.

b. The insulation shall meet the requirements of ASTM C547, Type 1.

c. Insulation shall be rated for use at temperatures up to 850 °F.

2. Materials and Construction:

a. The thermal conductivity shall not exceed both of the following:

1) 0.26 Btu/hr/ft^2/°F/in.-thickness at 50 °F mean temperature

2) 0.3 Btu/hr/ft^2/°F/in.-thickness at 200 °F mean temperature.

b. Vapor Retarder:

1) Insulation shall be provided with factory-applied vapor retarder.

2) The vapor retarder shall be an ASJ (all-service jacket) type meeting the requirements of ASTM C1136 Type 1 and consisting of laminated white kraft paper, reinforcing scrim and foil.

a) ASJ shall be rated for use over a temperature range of -20°F to 150°F and shall meet the requirements of ASTM C1136 Type 1.

c. Joints and Seams:

1) Provide joints and seams meeting one (1) of the following requirements:

a) Field cemented joints: All joints and seams shall be sealed with approved adhesive, and the joints covered with joint sealing tape at least 3-in. in width, permanently adhered.

b) Sealing strips: All longitudinal joints shall be sealed with integral adhesive sealing strip, and butt joints shall be covered with 3-in. width of vapor barrier butt joint strip tape.

d. Fittings, flanges, and valves:

1) Provide insulation meeting one (1) of the following requirements:

a) Fittings, flanges and valves shall be insulated with fiber glass molded or segmented insulation, and wrapped with joint sealing tape of matching color.

b) Alternatively, fittings, flanges and valves may be insulated with factory cut glass blanket.

B. Style “B” Insulation – Flexible Elastomeric Cellular Insulation

1. General:

a. Insulation shall be flexible elastomeric type, closed cell, cylindrical or sheet type as required by the application.

b. The insulation shall meet the requirements of ASTMC534 and ASTM D1056.

2. Materials and Construction:

a. The thermal conductivity shall not exceed the following:

1) 0.27 Btu/hr/ft^2/°F/in.-thickness at 75°F mean temperature.

b. Water absorption: Shall be less than 5% (ASTM D1056).

c. Water vapor permeability: Shall not exceed 0.10 perms/in. in accordance with ASTM E96 Procedure A.

d. Joints and Seams:

1) All joints shall be cut straight and butted with no gaps. Seal all joints with the manufacturer's recommended adhesive.

e. Fittings, flanges, and valves:

1) Seams and mitered joints shall be adhered using the manufacturer's recommended adhesive. Screwed fittings shall be sleeved and adhered with a minimum one-inch overlap onto the adjacent insulation.

2) Flanges, strainers, couplings and valves shall be insulated using donuts, then covered with sheet or oversize tubular insulation.

f. Coating:

1) Where insulation is installed outdoors, coatings shall be provided to protect the insulation from ultraviolet radiation.

2) Coatings shall be as recommended by the insulation manufacturer and approved by the Engineer.

C. Style "C" Insulation – Cellular Glass:

1. General:

a. The insulation shall meet the requirements of ASTM C552.

b. Where field-applied stainless steel jacketing is not required over the insulation, the insulation shall be provided with a factory-applied facing of aluminum foil laminated to glass fiber reinforced white vinyl facing.

c. Insulation shall be rated for use at temperatures from 0°F to 220°F, at a minimum.

d. Mechanical Properties:

1) Minimum density: 8.0 lbs/ft^3.

2) Compressive strength: 100 psi.

2. Materials and Construction:

a. The thermal conductivity shall not exceed the following:

1) 0.32 Btu/hr/ft^2/°F/in.-thickness at 75°F mean temperature.

b. Water absorption: Shall be less than 0.2% (as per ASTMC240).

c. Water vapor permeability: Shall not exceed 0.20 perms/in. in accordance with ASTM E96.

d. Joints and Seams:

1) Insulation joints shall be sealed with the insulation manufacturer's recommended vapor-resistant joint sealant.

2) Factory-applied facing shall have its longitudinal seams sealed with vapor-resistant adhesive and butt joints shall be wrapped with 3-in. width joint sealing tape, all as recommended by the insulation manufacturer and approved by the Engineer.

e. Fittings, flanges and valves:

1) Fittings, flanges and valves shall be insulated with preformed cellular glass insulation.

2) Fitted insulation segments shall be used on sizes for which preformed shapes are not manufactured, of the same material and thickness and applied in the same manner as for pipe insulation.

f. Coating:

1) Where indicated on the Contract Drawings or in the Contract Documents, the interior bore of the insulation shall be coated to prevent abrasion of the pipe.

2) For pipe operating near ambient temperature, the coating shall be a gypsum cement molding plaster.

D. Style "D" Insulation - Fiberglass Pipe and Tank

1. General:

a. Insulation shall be fiberglass pipe and tank insulation consisting of semi-rigid fiberglass board bonded to a flexible vapor retarder.

b. in accordance with ASTM C411.

c. Insulation shall be rated for use over an operating temperature range of 0°F to 650°F

2. Materials and Construction:

a. The thermal conductivity shall not exceed the following:

1) 0.27 Btu/hr/ft^2/°F/in.-thickness at 75 °F mean temperature.

2) 0.43 Btu/hr/ft^2/°F/in.-thickness at 250 °F mean temperature.

a. Vapor Retarder:

1) Insulation shall be provided with factory applied vapor retarder.

2) The vapor retarder shall be an ASJ (all service jacket) type consisting of laminated while kraft paper, reinforcing scrim and foil.

a) ASJ shall be rated for use over a temperature range of -20°F to 150°F and shall meet the requirements of ASTM C1136 Type 1.

3. Joints and Seams:

a. Joints and seams shall be sealed with approved adhesive, and the joints covered with joint sealing tape at least 3-in. in width, permanently adhered.

4. Fittings, flanges and valves:

a. Provide insulation meeting one (1) of the following requirements:

1) Fittings, flanges and valves shall be insulated with fiber glass molded or segmented insulation, and wrapped with joint sealing tape of matching color.

2) Alternatively, fittings, flanges and valves may be insulated with factory cut glass blanket.

E. Stainless Steel Jacketing:

1. General:

a. Provide stainless steel jacketing for insulated piping having an insulation outside diameter greater than 50-in. or if specified in Schedule 40 42 13-1, Process Piping Insulation and Jacketing.

1) Stainless steel jacketing shall have a modified Pittsburgh Z-lock on the longitudinal seam.

2. Materials and Construction:

a. Stainless steel jacketing shall be constructed of Type 316 stainless steel, not less than 0.016-in. thick.

b. Moisture Barrier:

1) Jacketing shall be provided with an integrally bonded moisture barrier.

c. Joints and Seams:

1) Adjacent sections shall butt together and shall be secured with a weather-proof butt strap.

d. Flanges, fittings, and valves:

1) All insulated fittings shall be finished in the same manner, using 0.024-in. thick type 316 stainless steel preformed fitting covers and fabricated covers made from the same material for valves, flanges, tees, in-line accessories, and other pipeline appurtenances.

2) Type 316 stainless steel end caps shall be provided at the ends of the pipelines.

F. Accessories:

1. Provide staples, bands, wires and cement as recommended by the insulation manufacturer and approved by the Engineer for the applications indicated.

2. Provide adhesives, sealers, and protective finishes as recommended by the insulation manufacturer and approved by the Engineer for the applications indicated.

G. Thermal Hanger Shields:

1. General:

a. Provide insulated pipe protectors consisting of a 360° high density, 100 psi, waterproofed calcium silicate inserts encased in 360° sheet metal.

1) On cold water pipes provide protectors with insulation extended 1-in. beyond the sheet metal shield.

2) On heat-traced pipe, protectors shall be provided with grooves to accommodate the heat tracing.

b. Provide the thickness of the insulation insert to be the same as the adjoining pipe insulation, and sheet metal gauge in accordance with the manufacturer's recommendations.

2. Materials and Construction:

a. Provide metal components manufactured of Type 316 stainless steel.

b. Pipe hangers and supports provided in conjunction with the thermal hanger shields shall meet the requirements of Section 40 05 07, Hangers and Supports for Process Piping.

2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Examine areas and conditions under which piping insulation is to be installed.

B. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable for insulation installation, as determined by the Engineer.

C. Examine process pipe insulation and jacketing prior to installation. Do not install damaged or wet insulation.

3.02 INSTALLATION

A. General:

1. Install process piping insulation in complete accordance with the manufacturer's printed instructions and the approved shop drawings. In addition:

a. Install piping insulation products in accordance with the Building Code of the City of New York.

b. Install all products in accordance with the recognized industry practices so that insulation serves its intended purpose.

c. Insulated thermal hangers shields shall be installed at all support points, except where otherwise indicated.

B. Installation of Process Piping Insulation:

1. Order of Installation:

a. Install insulation on pipe systems subsequent to the installation of heat tracing, painting, testing, and acceptance tests.

b. Piping shall be field tested and approved by the Engineer prior to installation of insulation.

2. Cleaning and Drying:

a. Pipe surfaces shall be cleaned and dried prior to insulating.

3. Insulation Surfaces:

a. Install the insulation materials with smooth, even and flush adjoining surfaces.

b. Butt insulation joints firmly together to form a complete and tight fit over the surfaces to be covered.

c. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run.

d. Do not use cut pieces or scraps abutting each other.

4. Vapor Barrier:

a. Maintain integrity of the vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

b. Vapor barrier materials shall be applied to form a complete, unbroken vapor seal over the entire insulated piping system.

5. Insulating Fittings:

a. Cover valves, fittings and similar items in each piping system with an equivalent thickness and composition of insulation as applied to the adjoining pipe run.

b. Install factory molded, precut or job fabricated units except where a specific form or type is indicated.

6. Installation through Walls, Floors, and Similar Piping Penetrations:

a. Unless indicated otherwise, piping insulation shall be extended without interruption through interior walls, floors and similar piping penetrations.

1) Annular spaces between pipe and pipe sleeves shall be thoroughly packed with fibrous glass blanket and caulked with mastic so as to be soundproof and vermin-tight.

2) Provide fibrous glass blanket with properties equivalent to the insulation Style installed on the piping.

b. Do not extend insulation through walls or floors that are fire rated or are required to be gas-tight.

7. Pipe Hangers:

a. Butt pipe insulation against pipe hanger insulation inserts.

b. For hot pipes, apply a 3-in. wide vapor barrier tape or band over the butt joints.

c. For cold piping apply a wet coat of the vapor barrier lap cement on butt joints and seal the joints with a 3-in. wide vapor barrier tape or band. Pipe hangers and supports shall be installed outside of the vapor seal.

8. Removable Items:

a. Install removable insulation sections on the following:

1) Devices that require access for maintenance of equipment

2) Items that can be removed, such as unions, screwed joints, flanges, strainers, etc.

C. Stainless Steel Jacketing:

1. Install jacketing in accordance with the manufacturer's recommendations and approved shop drawings.

2. Jacketing shall be secured with ¾-in. wide, 0.015-in. thick stainless steel bands at a maximum spacing of twelve inches.

3. All edges of strapping shall be factory deburred.

D. Pipe exposed to weather:

1. Pipe hangers and supports shall be on the outside of the stainless steel jackets, and shall not penetrate the jacketing.

2. Do not install thermal hanger shields on pipelines using cellular glass insulation.

a. At each such location, a preformed Type 316 stainless steel insulation shield shall be provided.

b. The insulation shield shall envelope at least the lower half of the insulated pipe and shall limit the compressive load on the insulation to 33 psig or less.

E. Sealing:

1. All jacket openings (such as at overlaps of jackets with thermal hanger shields, around valve stems and similar projections) shall be sealed with non-hardening, clear or white, waterproof sealing compound, so that upon completion the insulation is essentially watertight.

F. Painting:

1. Paint piping insulation in accordance with Section 09 91 00, Painting.

G. Cleaning:

1. Clean and remove all debris, waste materials, and loose foreign matter resulting from installation.

3.03 FIELD TESTING / QUALITY CONTROL

A. Not Used

3.04 STARTUP / DEMONSTRATION

A. Not Used

3.05 ADJUSTING / PROTECTION / CLEANUP

A. Protection and Replacement:

1. Protection:

a. Insulation shall be protected against dirt, water, chemical or mechanical damage before, during and after installation.

b. Follow methods which are required for protection of the insulation work during the remainder of construction period, to avoid damage and deterioration.

2. Replacement:

a. Any insulation or covering damaged prior to Final Acceptance of the Work shall be satisfactorily repaired or replaced, including units with vapor barrier damage and moisture saturated units.

3. Repair of Existing Insulation:

a. The Contractor shall repair sections of existing insulation as specified herein in the event damage occurs to sections of existing installation while Contractor is performing the Work.

1) Use insulation of same thickness as the existing insulation.

2) Install a new jacket lapping and sealer over the existing insulation.

3) If existing insulation is painted, paint new insulation to match the existing surface color.

4) If existing insulation is jacketed, replace damaged jacketing with new jacket.

END OF SECTION

NO TEXT ON THIS PAGE

SCHEDULE 40 42 13-1
PROCESS PIPING INSULATION AND JACKETING SCHEDULE

A. General:

1. The Contractor shall provide piping insulation and jacketing for mechanical, HVAC, and Plumbing piping in accordance with the requirements of Schedule 40 42 13-1.

    a. Section 40 06 01, Schedule for Exposed Piping, identifies additional mechanical piping that requires insulation and jacketing, and is not referenced in this Schedule 40 42 13-1.

    b. For mechanical piping, in the event of a discrepancy between insulation requirements identified by this Schedule 40 42 13-1, and insulation requirements specified in Section 40 06 01, Schedule for Exposed Piping, the Contractor shall provide the more stringent of the requirements.

    c. For all piping, in the event of a discrepancy between insulation requirements identified by this Schedule 40 42 13-1, and insulation requirements shown on the Contract Drawings or specified elsewhere in the Contract Documents, the Contractor shall provide the more stringent of the requirements.

A. Mechanical Piping System Insulation Schedule:

1. General:

    a. In addition to the requirements specified in Section 40 42 13, Process Piping Insulation, the Contractor shall provide piping insulation on the mechanical piping systems specified hereinafter.

2. Thickness: Where not indicated otherwise, the Contractor shall provide the following minimum insulation thicknesses:

    a. Insulation shall be 1-in. thick for pipe sizes up to and including 6 in. nominal diameter.

    b. Insulation shall be 1½-in. thick for pipe sizes greater than 6-in. nominal diameter.

3. Cold Piping Systems:

    a. Style: Insulation shall be Style A.

    b. Install on the following for the purpose of eliminating sweating:

        1) City water systems

        2) Service water systems

4. Hot Piping Systems (up to 250°F)

a. Style: Shall be as follows:

1) Insulation shall be Style A for pipe sizes up to and including 30-in. nominal diameter.

2) Insulation shall be Style D for pipe sizes greater than 30-in. nominal diameter.

b. Thickness: The Contractor shall provide the following minimum thicknesses for the purpose of reducing heat loss and preventing injury to workers:

1) Insulation shall be 1½-in. thick for pipe sizes up to and including 2-in. nominal diameter.

2) Insulation shall be 2-in. thick for pipe sizes 2½-in. through 6 in. nominal diameter, inclusive.

3) Insulation shall be 2½-in. thick for pipe sizes 8-in. through 30-in. nominal diameter, inclusive.

4) Insulation shall be 3-in. thick for pipe sizes greater than 30-in., nominal diameter.

c. Provide insulation on the following hot (up to 250°F) mechanical piping systems:

1) Heated sludge piping systems

2) Hot water piping systems

3) Hot air piping systems

4) Digester gas piping systems

5) Interior heat-traced piping systems

5. Steam and condensate piping systems:

a. Provide insulation for steam and condensate piping systems, as specified hereinafter, for the following piping systems, based on the temperature of the fluid:

1) Hot Low Pressure (up to 250°F) HVAC Piping Systems

2) Hot Fluids (251°F to 350°F) HVAC Piping Systems.

6. Exterior Piping Systems:

a. Style: Insulation shall be Style C.

b. Thickness: Insulation shall be a minimum 2-in. thick.

c. Install on the following:

1) Exterior piping systems that are heat-traced for freeze protection.

B. HVAC Piping System Insulation Schedule:

1. General:

a. In addition to the requirements specified in Section 40 42 13, Process Piping Insulation, the Contractor shall provide piping insulation on HVAC piping systems as specified hereinafter.

2. Sub-Freezing (0°F to 39°F) HVAC Piping Systems:

a. Style: Insulation shall be Style B.

b. Thickness:

1) Insulation shall be 1-in. thick for pipe sizes up to and including 1-in. nominal diameter.

2) Insulation shall be 1½-in. thick for pipe sizes greater than 1-in. nominal diameter.

c. Install on the following for the purpose of eliminating sweating:

1) Refrigerant suction lines systems between evaporators and compressors.

3. Cold (40°F to ambient) HVAC Piping Systems:

a. Style: Insulation shall be Style A.

b. Thickness:

1) Insulation shall be 1-in. thick for pipe sizes up to and including 4-in. nominal diameter.

2) Insulation shall be 1½-in. thick for pipe sizes greater than 4-in.

c. Provide insulation on the following cold (40°F to ambient) HVAC piping systems for the purpose of eliminating sweating:

1) HVAC chilled water supply and return piping systems.

2) HVAC make-up water piping systems.

3) Air conditioner condensate drain piping systems.

4. Hot Low Pressure (up to 250°F) HVAC Piping Systems:

a. Style: Insulation shall be Style A.

b. Thickness:

1) Insulation shall be 1½-in. thick for pipe sizes up to and including 2–in nominal diameter.

2) Insulation shall be 2-in. thick for pipe sizes 2½-in. through 6–in. nominal diameter, inclusive.

3) Insulation shall be 2½-in. thick for pipe sizes greater than 6-in. nominal diameter.

c. Provide insulation on the following hot low pressure (up to 250°F) HVAC piping systems for the purpose of reducing heat loss and preventing injury to workers:

1) HVAC hot water (glycol solution) supply and return piping systems

2) Hot gas refrigerant piping systems

3) Low pressure steam and condensate piping systems

5. Hot Fluids (251°F to 350°F) HVAC Piping Systems:

a. Style: Insulation shall be Style A.

b. Thickness:

1) Insulation shall be 2-in. thick for pipe sizes up to and including 1-in. nominal diameter.

2) Insulation shall be 2-½-in. thick for pipe sizes 1¼-in. through 4-in. nominal diameter, inclusive.

3) Insulation shall be 3½-in. thick for pipe sizes greater than 4-in. nominal diameter.

c. Provide insulation on the following hot fluids (251°F to 350°F) HVAC piping systems for the purpose of reducing heat loss and preventing injury to workers:

1) High pressure steam and condensate piping systems

6. Exterior Piping Systems:

a. Style: Insulation shall be Style C.

b. Thickness: Insulation shall be a minimum 2-in. thick, and greater if necessary and required to prevent freezing of the piping.

c. Install on the following:

1) Exterior piping systems that are heat-traced for freeze protection.

7. Insulation Omitted: For HVAC piping systems, omit insulation for the following:

a. Hot piping within radiation enclosures or unit cabinets,

b. Cold piping within unit cabinets provided that the piping is located over a drain pan and on heating piping beyond a control valve,

c. Piping located within heated space(s).

C. Plumbing Piping System Insulation Schedule:

1. General:
   a. In addition to the requirements specified in Section 40 42 13, Process Piping Insulation, the Contractor shall provide insulation for plumbing piping systems as specified hereinafter.
2. Cold Plumbing Piping Systems:
   a. Style: Insulation shall be Style A
   b. Thickness: Insulation shall be 1-in. thick.
   c. Provide insulation on the following cold plumbing piping systems for the purpose of eliminating sweating:
      1) Potable cold water piping systems
      2) Interior above-ground storm water piping systems
      3) Plumbing vents within 6 lineal ft of a roof opening
      4) Drain piping systems from drip pans
3. Hot Plumbing Piping Systems:
   a. Style: Insulation shall be Style A
   b. Thickness:
      1) Insulation shall be 1-in. thick for pipe sizes up to and including 6-in. nominal diameter.
      2) Insulation shall be 1½-in. thick for pipe sizes greater than 6-in. nominal diameter.
   c. Provide insulation on the following hot plumbing piping systems for the purpose of reducing heat loss and preventing injury to workers:
      1) Potable hot water piping systems
      2) Potable hot water recirculating piping systems
      3) Hot drain piping systems
      4) Tempered water piping systems
4. Insulation Omitted: For plumbing piping systems, omit the insulation for the following:
   a. Chrome-plated exposed piping (except for handicapped fixtures).
   b. Air chambers.
   c. Unions.
   d. Strainers.
   e. Check valves.
   f. Balance cocks.

g. Flow regulators.

h. Drain lines from water coolers.

i. Drainage piping located in crawl spaces or tunnels.

j. Buried piping.

k. Fire protection piping.

l. Pre-insulated equipment.

THE CITY OF NEW YORK

DEPARTMENT OF
ENVIRONMENTAL PROTECTION

Invitation for Bids for Furnishing all Labor and Material Necessary and Required for:

KEN-EAST-2

KENSICO-EASTVIEW CONNECTION

KENSICO SITE PREPARATION

Volume 2 of 2
Contract Terms and Specifications
(with separate Bid Booklet)

April 2023