TETRA TECH
ARCHITECTS & ENGINEERS

10 Brown Road
Ithaca, New York 14850
607-277-7100

Ithaca, New York
Fanni.ngdale, New York
Albany, New York

SED NO. 62-18-01-06-0-007-0J 8
62-1 8-01-06-0-002-014
62-I8-01-06-0-003-014
62-18-0J-06-0-005-015
62-18-01-06-0-001-019

VOLUME 2

WALLKILL CENTRAL SCHOOL DISTRICT

WALLKILL, NEW YORK

PROJECT NO. 17597-22001

RECONSTRUCTION TO
WALLKILL SENIOR HIGH SCHOOL
JOHN G. BORDEN MIDDLE SCHOOL
OSTRANDER ELEMENTARY SCHOOL
PLATTEKILL ELEMENTARY SCHOOL
LEPTONDALE ELEMENTARY SCHOOL

NOVEMBER 4, 2022

The engineer that has signed this document certifies that to the best of their knowledge, information and belief, the asbestos plans and specifications are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, Constrnction Standards of the Commissioner of Education, New York State Department of Labor Part 56 of Title 12, and the United States Environmental Protection Agency Hazard Emergency Response ACT Regulations. Anthony Meluso is accredited to the EPA and New York State under AHERA Regulations as an Asbestos Project Designer (Asbestos Handling Certificate Number 94-03914).

To the best of the Architect's knowledge, info1mation and belief, the design of this project conforms to all applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Constrnction Code, and the building standards of the New York State Education Department.

SET NO. _____

TABLE OF CONTENTS

PROJECT MANUAL

Volume 2 of 2

BIDDING REQUIREMENTS AND CONDITIONS OF THE CONTRACT

PLEASE NOTE

All sections of the following **SPECIFICATIONS** are sequentially numbered, beginning with Page 1 and concluding with the last numbered page bearing the marking "END OF SECTION -- -- --".

Sections may include additional attachments as noted in following list of Specification sections.

SPECIFICATIONS

SECTION 21 24 00 – DRY CHEMICAL FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Pre-engineered Dry Chemical Fire Suppression System including agent storage cylinders, nozzles, control devices, detectors, energy shut off device(s) and all other equipment necessary for a complete operational system.

B. Pre-engineered dry chemical fire suppression system designed and installed by Contractor designed for Class A, B, or C fires as appropriate for areas being protected and include safety factor. Use dry chemical indicated and in concentration suitable for normally occupied areas.

1.3 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psigminimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. The design for this hazard for Total Flooding and provide automatic detection and actuation of the extinguishing system.

2. The fire suppression equipment designed to operate at a minimum storage temperature of -40 deg F.

3. Designed for outdoor use and tested at 10 mph wind conditions.

4. Design piping and installation in accordance with NFPA 17 and the Dry Chemical Fire Suppression System manufacturer’s written Instruction Manual.

5. Only equipment that is specifically listed and compatible for use with the extinguishing system shall be used.

6. The use of at least one manual station for system release must be installed in accordance with NFPA 17. The manual station can be of either electric or mechanical means. Notification to the building fire alarm panel or security system must be provided in the event of any trouble or alarm signal from the fire suppression system.

7. The dry chemical fire suppression system must be able to be released automatically from one of two different means of actuation: either pneumatic or electric thermal detection.

8. Provide equipment shut down by relay contact outputs with power switched to it by way of Cylinder Control Head (Releasing Device) micro-switches. Building fire alarm or security system notification can be achieved through the same means.

9. All agent cylinders will discharge simultaneously upon system actuation.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include design calculations. Include the following for hazard-area enclosure, drawn to scale:

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

2. Discharge Nozzle and Piping Layout:

a. Plans, elevations, sections, details, and attachments to other Work. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

b. Coordinate location of discharge nozzles and piping to eliminate interference with other work.

c. Coordinate height of discharge nozzles to eliminate interference with School Buses driving under the canopy.

d. Locate dry chemical agent tanks, piping and piping supports on top of the fuel canopy.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. Permit Approved Drawings: Working plans, prepared according to NFPA 17, that have been approved by authorities having jurisdiction.

2. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

3. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer (where applicable) indicating compliance with applicable “Qualifications” requirements specified below in “Quality Assurance” article.

4. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire suppression system specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Applicable Standards: Sprinkler system equipment, specialties, accessories, design, installation, and testing shall comply with the following:

1. Fire Code of New York State.
2. NFPA 17 – Standard for Chemical Extinguishing Systems.
3. NFPA 30 – Standard for Flammable & Combustible Liquids.
4. NFPA 70 – National Electric Code Materials and devices essential for successful system operation shall be UL listed and FM approved.
5. UL 1254: Standard for Pre-Engineered Dry Chemical Extinguishing System Units.

B. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

    a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

C. Source Limitations: Obtain extinguishing agent and equipment through one source.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. ASME Compliance: Fabricate piping to comply with ASME B31.1, "Power Piping."

F. NFPA Compliance: Fabricate and label clean-agent extinguishing systems to comply with NFPA 17, "Clean Dry Chemical Extinguishing Systems."

1.8 COORDINATION

A. Coordinate layout and installation of discharge nozzles with other construction that penetrates canopy, including structural members, light fixtures or other equipment.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Schedule 40, Type F or Type S, Grade A. Pipe ends may be factory or field formed to match joining method.
B. Galvanized -Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
C. Galvanized Steel Couplings: ASTM A 865, threaded.
D. Galvanized Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

2.2 PIPING JOINING MATERIALS

A. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.3 CYLINDER AND AGENT

A. Basis-of-Design Product: Subject to compliance with requirements, provide Tyco Fire Protection Products; Pyro-Chem “Attendant II” or a comparable product by one of the following:

1. Badger Fire Protection
2. Kidde Fire Systems; Model IND Industrial Dry Chemical Fire Suppression System.

B. Dry Chemical Agent: BC, (sodium bicarbonate). Cylinder valves must be equipped with a pressure gauge. The design concept shall be of the pre-engineered type with piping parameters and discharge nozzle types pre-determined by the fire suppression system manufacturer. No hydraulic calculations shall be used to accomplish the piping design.

C. Cylinders: Steel cylinders manufactured, tested and marked in accordance with DOT 4B 35 or DOT 4B 500 used to store agent.

1. Cylinders charged with dry nitrogen to 360 psig @ 70 F degrees.

2. Cylinder Valve: Pressure sealed poppet-type valve with brass body, stainless steel stem with rubber seat washer, fusible safety relieve and pressure gauge.

3. Bracketing: Vertically mounted with steel bracket for mounting to rigid object. Bracket to be capable of supporting the weight of the filled cylinder and the concussion of cylinder discharge.

2.4 DISTRIBUTION NOZZLES

A. Fire suppression system supplied distribution nozzles to distribute agent throughout the hazard area. Model, quantity, location and orientation of nozzles in accordance with suppression system manufacturer’s instructions

B. Nozzle covers: Nozzles to include covers to prevent foreign matter from clogging discharge nozzle.

2.5 ACTUATION CONTROLS

A. Control Head: Listed for detection and agent release.

1. Control head to activate up to five (5) agent cylinders utilizing carbon dioxide pilot cartridge. Control head to include a visual indicator for “SET” or “FIRED” status and a secondary power supply in the event of the loss of primary power.

B. Detection:

1. Fixed temperature mechanical or electrical thermal detectors.
2. When the temperature of the hazard area exceeds the rating of any detector, the detector to release tension in control head cable to active the control head.
3. Mechanical manual actuation station to include remote mechanical pull station

C. Auxiliary output:

1. Dry contacts within the control head to shut off power to equipment within the hazard area in event of system actuation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor’s acceptance of conditions.

3.2 INSTALLATION

A. Install the Work of this Section in accordance with NFPA 17, manufacturer’s printed installation instructions, and approved Shop Drawings, and all applicable State and local codes.
B. Size system pipe and fittings in accordance with the system manufacturer’s Technical Manual. No substitutions are allowed.
C. Install a union in the discharge piping conveniently close to the cylinder valve to permit disconnection for inspection and service.
D. Install pipe hangers and supports in sufficient numbers and suitable spaced to adequately support the piping.
E. Label all devices with instructions for proper operation.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Threaded Joints: Thread 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 restore full ID. Join pipe fittings and valves as follows:

1. No joint sealant shall be used in the discharge piping.
2. Exception: Teflon tape may be used to help ensure a snug fit.

3.4 FIELD QUALITY CONTROL

A. Final System Tests:

1. Notify the Owner’s Project Representative when the Work of this Section is ready for testing.

2. Perform the tests in the presence of the Owner’s Project Representative.

3. Perform tests by a certified service technician in accordance with NFPA 17:

a. Determine that the system has been properly installed and will function as intended.

b. Certify that the installation has been made in accordance with the approved plans, where required, and the manufacturer's design, installation, and maintenance manual.

c. Verify that nozzles and pipe sizes are in accordance with approved plans, where required, and the manufacturer's design, installation, and maintenance manual.

d. Verify that piping supports are securely fastened.

e. Physically check piping for tightness prior to the acceptance test.

f. Perform a test using nitrogen or dry air on the piping network at a pressure not to exceed the normal operating pressure of the extinguishing system and to verify that nitrogen or dry air has discharged out of each nozzle in the system.

g. Verify the method of verification is acceptable to the authority having jurisdiction.

h. Piping shall not be hydrostatically tested.

i. Verify the labeling of devices with proper designations and instructions.

j. Verify the system is connected to a building alarm system.

k. Verify the alarm-sounding or notification devices and remote annunciation devices are functional.

l. Verify that all manual release devices (manual pull stations) are readily accessible and accurately identified.

m. Verify that the releasing control panel is provided, connected to a dedicated circuit and labeled properly.

n. Verify that the releasing control panel is readily accessible and restricted from unauthorized personnel.

B. Following final system testing and acceptance, restore system to normal condition.

C. Perform site tests in accordance with Division 01 Section “Quality Requirements”.

D. Testing to be witnessed by authority having jurisdiction and Owner’s representative.

E. Upon completion of tests, ensure each cylinder in both initial and reserve banks contains correct chemical and weight of extinguishing agent and expellant gas. Restore systems to normal condition.

F. Manufacturer of system shall submit letter on completion of installation and testing certifying that system is in full compliance with NFPA and New York State Education Department requirements.

3.5 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 17.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire suppression system.

END OF SECTION 21 24 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Definitions, references, and abbreviations.
2. General regulatory requirements.
3. General requirements regarding site/field conditions including existing conditions and field measurements.
4. Sequencing and scheduling including coordination.
5. Definition of design equipment and procedures for consideration of specified equivalents, proposed equivalents, or substitutions.
6. Transition fittings.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SYSTEM DESCRIPTION

A. Provide complete systems, properly connected, tested, balanced, adjusted, and ready for operation, including all necessary and required controls, safeties, details and accessories, including (but not limited to):

1. Water distribution systems.
2. Fuel oil storage tank systems.
3. Fuel oil piping systems.
4. Electrical control wiring to equipment furnished in this Contract.
5. Miscellaneous items.

1.5 COORDINATION PROCEDURES

A. Coordinate construction operations and construction schedule of plumbing work with other contractors in accordance with Section 01 31 00 “Project Management and Coordination” and as modified below.

1. Pre-Installation Conference: Attend pre-installation conference. Arrange for all subcontractors to be in attendance.

2. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

3. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Section 08 31 13 "Access Doors and Frames."

4. Coordinate Plumbing Work with HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, and electric code clearance and building systems.

5. Notify Owner's Project Representative and Architect in case of unresolved interferences prior to installation of Plumbing Work.

6. Adjust exact size, location and offsets of pipes to achieve reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.

1.6 SUBMITTALS, GENERAL

A. Comply with requirements of SECTION 01 33 00 “Submittal Procedures” for each individual Section and as modified below.

B. Submit all action submittals required by individual Section concurrently.

1. As-Specified Products: If product to be incorporated into Project is as specified by name and product designation in Part 2 of product specification, and will be installed as specified in Part 3, and only where allowed as such in submittal portion of product specification, then submit "**As-Specified Verification Form**" (attached to SECTION 01 33 00 "Submittal Procedures") in lieu of "Product Data" identified in the Action Submittal.

2. Do not use "**As Specified Verification Form**" unless specifically indicated in detailed product specification.

3. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Product Data requirements specified.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Penetration firestopping materials.

1.8 INFORMATIONAL SUBMITTALS

A. Coordination Drawings.
B. Contract Closeout Submittals: Comply with requirements of Section 01 77 00 "Closeout Procedures".

1.9 QUALITY ASSURANCE.

A. Provide installation, testing and materials in accordance with Federal, State and Local Building, Health, Plumbing and Electrical Codes, Laws, Ordinances, and Regulations that apply to Plumbing Work.

1. Comply with applicable requirements of following documents:

a. New York State Uniform Fire Prevention and Building Code.
b. 2020 Building Code of New York State.
c. 2020 Fire Code of New York State.
d. 2020 Plumbing Code of New York State.
e. 2020 Mechanical Code of New York State.
f. 2020 Fuel Gas Code of New York State.
g. 2020 Energy Conservation Construction Code of New York State.
h. New York State Education Department Manual of Planning Standards.
i. In event of a conflict between the Codes identified above and Contract Documents, comply with more stringent requirement.

2. Obtain and pay for necessary inspections, certificates, and permits from applicable agencies. Perform required tests in accordance with regulation of agency having jurisdiction. Submit certificates of approval prior to the date of Substantial Completion as defined in Section 01 77 00 “Closeout Procedures”.

B. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is submitted to the Architect and approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Packing and Shipping: Ship materials in manufacturer’s containers, fully identified with manufacture’s name, trade name, type, class, style, model, grade, size and color.

C. Storage and Protection:

1. Store materials, equipment, fixtures, pipe, fittings, and attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.

2. Furnish extra materials identified in technical sections, in original manufacturers’ containers and packaging, to Owner at location identified during prebid conference. Obtain receipt from Owner upon delivery of extra materials and send copy of receipt to Architect.

3. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.

1.11 PROJECT/SITE CONDITIONs

A. Existing Conditions:

1. Reuse equipment only as indicated on Drawings.

2. All usable material and equipment not being reused is to be offered to the Owner. If accepted by Owner the Contractor shall deliver to a location on District grounds designated by the Owner.

3. All other material and equipment to be removed, shall be removed from the site and legally disposed of by the Contractor

B. Rodent Proofing:

1. Openings for Pipes: In or on structures where openings have been made in walls, floors or ceilings for the passage of pipes, such openings shall be closed and protected by the installation of approved metal collars that are securely fastened to the adjoining structure.

C. Protection of Plumbing Systems:

1. Corrosion: Provide corrosion protection for pipes passing through concrete or cinder walls and floors or buried in corrosive soil conditions.

   a. Provide oversized sleeves or core drilled holes to eliminate rubbing on above grade piping installations.
   b. Refer to individual Division 22 piping Sections for corrosion protection on buried piping installations in corrosive soil conditions.

2. Stress and Strain: Install plumbing systems in a manner that prevents stresses and strains that exceed the structural strength of the pipe. Install piping systems to accommodate expansion, contraction and structural settlement.

3. Freezing: Do not install water, soil, waste or storm piping outside of a building, in attics or crawlspaces, conceal in outside walls or in any other place subjected to freezing temperatures without providing measures to keep the contents of the piping system from freezing.

D. Field Measurements:

1. Layout of equipment, piping, and similar components in Drawings is diagrammatic. Review Drawings to identify interference with other construction and verify dimensions at Site prior to beginning installation.

   a. Obtain exact location of all items and openings and confirm all existing conditions in field.

   b. Obtain exact location and roughing requirements for all equipment furnished by others, but installed by this Contractor before roughing. Owner reserves right to make reasonable changes prior to "roughing-in" without increase in Contract Sum.

2. Report any conflicts to Architect in writing before beginning installation.

3. Provide fittings, horizontal and vertical offsets, elevation changes, etc. required to install Plumbing Work. Do not infer that Drawings show level of detail indicating every offset, elbow, union, fitting, elevation changes, or other aspect required for complete installation.

4. Install Plumbing Work with proper provisions for removal and/or access to valves, traps, cleanouts, etc.

1.12 SEQUENCING AND SCHEDULING

A. Perform Plumbing Work in cooperation with Owner, Architect, Construction Manager, and all Contractors on this Project, and other separate Contractors at the Site.

1. Coordinate Plumbing Work with construction schedule requirements in Division 01
2. Coordinate all submittals with the construction schedule and with requirements and schedules contained in Section 01 33 00 “Submittals Procedures.”
3. Immediately report any delays in receipt of materials required for Plumbing Work including circumstances causing delays.

B. Refer to Division 01 for cooperation between Contractors. Prior to start of construction:

1. Obtain from Contract Drawings or Architect, exact location of items and openings in construction. Conform to existing conditions in field.

2. Review applicable Shop Drawings of all Contracts.

3. If conflict occurs between Contract Drawings, advise Architect in writing before beginning installation and comply with Architect's directions.

4. Obtain exact location and roughing requirements for equipment furnished by other Contractor or by Owner, but installed by Contractor responsible for Plumbing Work before beginning roughing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Minimum Material Requirements:

1. Construct potable water systems and equipment according to AWWA standards.

2. Provide electrical equipment and systems meeting UL standards and requirements of NEC.

3. Provide UL label on all equipment and material with listing service.

4. Material Flammability:

a. Flame spread rating of 25 or less.
b. Smoke developed rating of 50 or less.

5. Equipment Verification: Carefully check manufacturer's drawings and specifications as they affect their equipment; follow factory instructions for roughing, installation, connection, filling, lubrication, testing, balancing, adjusting, alignment, wiring, and start-up operation.

2.2 CONCRETE BASES AND SUPPORTS

A. Equipment Bases: 3-1/2 inches thick minimum, reinforced with 6x6-W1.4xW1.4 welded wire mesh, minimum 1-1/2 inches cover, doubled over 12 inches on long edges, unless otherwise specified.

2.3 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.4 SEALANTS

A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."

B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Building Systems; Omniplus.
b. Dow Corning Corporation; 786 Mildew Resistant.
c. GE Advanced Materials - Silicones; Sanitary SCS1700.

2.5 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.6 PAINT AND FINISHES

A. Refer to Section 09 91 00 "Painting" for interior and Section 09 96 00 “High-Performance Coatings” for exterior painting and finishing of plumbing piping, equipment and systems.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

1. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.
7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Matco-Norca, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.

c. Pressure Rating: 125 psig minimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.8 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Piping Specialties Products.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc.; a Sensus company.
g. Viking Johnson.

2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.

3. Standard: AWWA C219.

4. Center-Sleeve Material: Manufacturer's standard.

5. Gasket Material: Natural or synthetic rubber.

6. Pressure Rating: 150 psig minimum.

7. Metal Component Finish: Corrosion-resistant coating or material.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Charlotte Pipe and Foundry Company.
b. Harvel Plastics, Inc.
c. Spears Manufacturing Company.

2. Description:

a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Colonial Engineering, Inc.
b. NIBCO Inc.
c. Spears Manufacturing Company.

2. Description:

a. CPVC four-part union.
b. Brass or stainless-steel threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Section 02 41 19 "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Remove Piping: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Abandon Piping in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Remove Equipment: Disconnect and cap services and remove equipment.
4. Remove and Reinstall Equipment: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Remove and Salvage Equipment: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is rendered unserviceable during the process of demolition, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Unless specific mounting heights are indicated, install equipment to allow maximum possible headroom.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Sections, Section 22 05 29 “Hangers and Supports for Plumbing Piping and Equipment”, for detailed additional requirements.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
C. Field Welding: Comply with AWS D1.1.

3.4 CONCRETE BASES

A. Refer to individual Division 22 piping and equipment Sections for specific concrete base and support requirements.

3.5 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

3.6 SEALANTS

A. Install sealants according to the requirements specified in Section 07 92 00 "Joint Sealants."
B. Refer to individual Division 22 plumbing fixture and equipment Sections for specific sealant and caulking requirements.

3.7 FIRESTOPPING

A. Install firestopping according to the requirements specified in Section 07 84 13 "Penetration Firestopping."

B. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Plumbing Work installation.

   a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

   b. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

3.8 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Section 09 91 00 "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.9 DIELECTRIC FITTINGS

A. Install dielectric fittings according to the specific requirements in the Division 22 Sections specifying piping systems.

3.10 TRANSITION FITTINGS

A. Install transition fittings according to the specific requirements in the Division 22 Sections specifying piping systems.

END OF SECTION 22 05 00

SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Gauges.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Dial-type pressure gauges.
2. Valves.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Weiss Instruments, Inc; Series 4CTSLF or comparable product by one of the following:

a. Ernst Flow Industries.
b. Tel-Tru Manufacturing Company.
c. Trerice, H. O. Co.

2. Standard: ASME B40.100.

3. Case: Liquid-filled, sealed, solid-front, pressure relief type(s); stainless steel; 4-1/2-inch nominal diameter.

4. Pressure-Element Assembly: Phosphorus bronze tube unless otherwise indicated.

5. Pressure Connection: Lead-free brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: White coated metal lithographed with black scale markings graduated in psi.

8. Pointer: Dark-colored metal.

9. Window: Safety glass lens.

10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.2 GAUGE ATTACHMENTS

A. Valves: Lead-free brass or stainless-steel quarter turn ball valve, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Beginning installation constitutes Contractor's acceptance of substrates and conditions.
B. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

3.2 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of gauges to proper angle for best visibility.

3.4 PRESSURE-GAUGE SCHEDULE

A. Install liquid-filled sealed solid-front, pressure-relief, direct-mounted, metal case pressure gauges at the following locations:

1. Water service piping at point of entry into building.
2. Inlets and outlets of each domestic water booster pump.

B. Install liquid-filled, sealed, solid-front, pressure-relief, direct-mounted, metal case pressure differential gauges at inlets and outlets of circulation pumps.

3.5 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.
B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ball valves.
2. Check valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. RPTFE: Reinforced polytetrafluoroethylene.
E. SWP: Steam working pressure.
F. WOG: Water, oil, gas.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1. Ball valves.
2. Check valves.

1.6 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.

3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder-joint connections.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-61-8 Commercial Hot 180°F (includes Annex F and G).
3. NSF/ANSI-372 for lead-free valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for cast copper solder-joint connections.
5. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
6. ASME B16.34 for flanged and threaded end connections.
7. ASME B16.51 for press joint.
8. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Type:

1. Hand Lever: For quarter-turn valves NPS 4 and smaller.

H. Valves in Insulated Piping:

1. Ball Valves: Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.

I. Refer to valve schedule articles for applications of valves.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Lead-Free, Two-Piece with Full Port, and Stainless-Steel Trim, Solder or Threaded Ends (NPS 2 and smaller):

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model S/T-585-66-LF-NS or a comparable product by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves; 70LF-140, 70LF-240.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc; LFB6000-SS, LFB6001-SS.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Soldered or threaded.
g. Seats: PTFE or TFE.
h. Stem: Type 316 stainless steel.
i. Ball: Type 316 stainless steel, vented.
j. Port: Full.
k. Handle: Insulated extension handle.

B. Bronze Ball Valves, Lead-Free, Two-Piece with Full Port, and Stainless-Steel Trim, Press Ends (NPS 2 and smaller):

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model PC-585-80-LF-NS or a comparable product by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: Minimum 200 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Press.
f. Press Ends Connections Rating: Minimum 200 psig.
g. Seats: Reinforced PTFE.
h. Stem: Bronze or brass.
i. Ball: Stainless steel.
j. Port: Full.
k. O-Ring Seal: EPDM.
l. Handle: Insulated extension handle.

2.4 BRONZE SWING CHECK VALVES

A. Bronze, 200 CWP, 125 WSP Swing Check Valves with Metal Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Webstone 1054W Series or comparable product by one of the following:

a. Hammond Valve.
b. Milwaukee Valve Company.

2. Description:

a. Sizes: 1/4 to 4 inch.
b. Certification: Certified lead free toin accordance with NSF/ANSI 61, ISO 9001.

c. CWP Rating: 200 psig.
d. Body Design: Horizontal or vertical (flow in upward direction) flow.
e. Body Material: Lead free, corrosion resistant.
f. Ends: Threaded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

F. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Water Service Entry: Gate valve.
2. Shutoff Service: Ball valves.
3. Throttling Service: Ball valves.
4. Pump-Discharge Check Valves: NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Ball Valves: Two-piece with full port and stainless steel trim. Provide with threaded, solder or press connection-joint ends.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal hanger-shield inserts.
3. Fastener systems.
4. Roof mounted pipe stands.
5. Equipment supports.

1.3 DEFINITIONS

A. Hostile Environments: Exterior installations, basements, crawlspaces or spaces where corrosive chemicals are stored.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Roof mounted pipe stands.
2. Insulation shields.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Threaded rod.
2. Adjustable clevis hanger.
3. Adjustable swing-ring band hangers.
4. Adjustable swivel-ring band hangers.
5. Hinged pipe clamps.
6. Riser clamps.
7. Beam Clamps.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Anvil International; a subsidiary of Mueller Water Products Inc.
2. Cooper B-Line, Inc.
3. ERICO International Corporation.
4. PHD Manufacturing, Inc.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Buckaroos, Inc.
2. CADDY; brand of nVent Electrical plc.
3. Carpenter & Paterson, Inc.
4. Pipe Shields Inc.

B. Insulation-Insert Material for Type "B" and “E” Insulated Piping Support Assemblies: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Type "C" and “F” Insulated Piping Support Assemblies: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.
d. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper B-line; brand of Eaton, Electrical Sector.
b. Empire Tool and Manufacturing Co., Inc.
c. Hilti, Inc.

d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated or stainless steel.

3. Outdoor Applications: Stainless steel.

2.6 ROOF MOUNTED PIPE STANDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. MAPA Products.
2. Miro Industries, Inc.
3. PHD Manufacturing, Inc.

B. General Requirements for Pipe Stands:

1. Shop-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
2. Gently rounded edges to prevent damage to roof membrane.
3. Drainage ports to prevent ponding.
4. Carbon black additive in polycarbonate, when used, for UV stabilization.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two stainless-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
5. Pipe Supports: Roller.
6. Hardware: Stainless steel.
7. Accessories: Protection pads.
8. Height: 12 inches above roof.

D. Protection Pads: 15-3/4 by 19-3/4 inch rectangle, 1/8 inch thick, flexible PVC with carbon black additive for UV stabilization.

2.7 MATERIALS

A. Carbon Steel: ASTM A1011/A1011M.

B. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

C. Stainless Steel: ASTM A240/A240M.

D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. 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.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ROOF MOUNTED SUPPORT INSTALLATION

A. Determine that roof structure, roof insulation, and roof membrane are structurally adequate to support weight of pipe, duct, conduit, and supports and hangers.

B. Install supports and hangers in accordance with manufacturer's recommendations.

C. Install supports at maximum spacing of 10 feet unless closer spacing is required due to weight of pipe or conduit contents or greater spacing is specifically allowed by manufacturer; space and adjust to support an equal amount of weight; do not exceed manufacturer's recommended load limits.

D. Remove roofing aggregate from area 2 inches larger than support base; comply with roofing manufacturer's requirements to maintain roofing warranty.

E. Install an additional sheet of roofing material, support pad, or deck plate beneath each support base.

F. Support Pads:
1. Apply support pad on cleaned area.
2. Center bases on top of support pads.

G. Pipe Supports: Center beneath pipe so that pipe is located squarely over and through cradle or hanger. Set pipe in support without dropping or causing undue impact.

H. Adjustable Supports: Adjust height of each support to achieve proper height and level before installing supported item.

1. Level rollers or struts before installing pipe.
2. Make final height adjustments to provide even distribution of load on all supports.

I. Fixed Anchor Supports: Prior to installation of roof decking, insulation and roof membrane attach support to roof structure as indicated on drawings.

1. After installation of roof decking, insulation and membrane, install pipe or roof top mechanical supports used in connection with fixed anchor supports.

2. Install piping or mechanical units on each support.

3.6 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.7 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in and Section 09 96 00 "High-Performance Coatings" for exterior installations.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.8 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Piping in general service applications:

a. Bare Copper Piping Systems:

1) NPS 1-1/4 and Smaller: Adjustable, plastic coated copper swivel loop hanger for suspension of non-insulated stationary pipes.
2) NPS 1-1/2 and Larger: Copper plated clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

b. Bare Ferrous Piping Systems:

1) NPS 1-1/4 and Smaller: Heavy duty electro-galvanized steel swivel loop hanger for suspension of non-insulated stationary pipes.
2) NPS 1-1/2 and Larger: Electro-galvanized clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

c. Insulated Piping Systems:

1) NPS 2 and Smaller: Electro-galvanized clevis hanger with galvanized steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.

2) NPS 2-1/2 and Larger: Electro-galvanized clevis hanger with separate or integral galvanized steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment and piping labels.
2. Valve tags and signage.
3. Warning tape.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Warning signs/labels.
2. Valve function signage.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Equipment labels.
2. Pipe labels.

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

D. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve-numbering scheme.

F. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

1.5 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 locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

2. Letter and Background Color: As indicated for specific application under Part 3.

3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

1. Refer to “COLOR CODING OF FUEL TANK FILL PORTS” paragraph in Part 3 below.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Not accepted.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.3 STENCILS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Craftmark Pipe Markers.
2. Kolbi Pipe Marker Co.
3. Marking Services Inc.
4. Pipemarker.com; Brimar Industries, Inc.

B. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum, brass, or fiberboard.
2. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Letter and Background Color: As indicated for specific application under Part 3.

2.4 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.

2. Craftmark Pipe Markers.
3. Kolbi Pipe Marker Co.
4. Marking Services Inc.
5. Pipemarker.com; Brimar Industries, Inc.
6. Seton Identification Products; a Brady Corporation company.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass link chain or S-hook.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

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 locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.
D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

D. Provide nameplates for equipment with identifying name of equipment and function.

E. Provide name plates for panels identifying name of panel and function, function of switches, control devices, panel lights, and buttons and securely fasten to panels.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Domestic Cold-Water Piping: Black letters on an ANSI Z535.1 safety-green background.

G. Water Service Piping: Provide Piping Identification Labels on exposed water service piping exceeding 10 feet in length prior to backflow preventer device at 5 foot intervals.

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: : Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Color: Natural.
2. Letter Color: Black.

C. Provide valve tag for each piping systems valve located above grade.

1. Valve Directory: Provide neat typewritten directory listing valve function, location and identification number.
2. Valve Numbering System: Extension of and compatible with existing valve numbering system, where valves are installed in existing building or in addition to existing building.
3. Verification: Verify existing valve numbers in field and provide valve numbering avoiding duplication of existing numbers.

3.6 COLOR CODING OF FUEL TANK FILL PORTS

A. Permanently mark all fill ports to identify product inside tank in manner consistent with color and symbol code of American Petroleum Institute as follows:

1.	#2 fuel oil	Green.
2.	Diesel	Yellow.
3.	Lower unleaded gasoline	White with black cross.
4.	Middle unleaded gasoline	Blue with white cross.
5.	Higher unleaded gasoline	Red with white cross.

6. Verify with Owner fuel types prior to color-coding of fill port.

B. Use following symbols:

1. Circle for gasoline products and vapor recovery lines.
2. Hexagon for other distillates.
3. Paint black border around white symbol and white field for field products containing extenders such as alcohol.

END OF SECTION 22 05 53

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Piping joining materials.
4. Transition fittings.
5. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Lab results for lead testing prior to commencing work.
B. System purging and disinfecting activities report.
C. Field quality-control reports.
D. Lab results for biological testing showing samples negative for coliform bacteria.

1.5 QUALITY ASSURANCE

A. Installer qualifications: Installer shall have successfully completed the Uponor Piping Systems Training Course and is able to provide proof/verification. Course shall be conducted by the manufacturer or a manufacturer's representative.

1. Regulatory requirements and approvals: Ensure the piping distribution system complies with all applicable codes and regulations.

2. Certifications: Provide letters of certification indicating: Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.

1.6 PRE-INSTALLATION MEETINGS

A. Verify project requirements, excavation conditions, system performance requirements, manufacturer's installation instructions and warranty requirements.
B. Review project construction timeline to ensure compliance or discuss modifications as required.
C. Interface with other trade representatives to verify areas of responsibility.
D. Establish the frequency and construction phase the project engineer intends for site visits and inspections by the tubing manufacturer's representative.

1.7 FIELD CONDITIONS

A. Interruption of Existing Water Service: Refer to “Existing Utility Interruptions” paragraph of Section 01 12 00 “Multiple Contract Summary-Project Schedule” for requirements associated with interrupting the existing water service to facilities occupied by the Owner.

B. Coordinate potable water lead testing with Owner prior to starting any construction.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with NSF 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type L.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Elkhart Products Corporation.
b. Lee Brass.
c. NIBCO INC.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Elkhart Products Corporation.
   b. Mueller Streamline Company.
   c. NIBCO Inc.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Elkhart Products Corporation.
   b. Lee Brass.
   c. NIBCO Inc.

F. Copper Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Elkhart Products Corporation.
   b. Lee Brass.
   c. NIBCO Inc.

2. MSS SP-123.

3. Cast-copper-alloy, hexagonal-stock body.

4. Ball-and-socket, metal-to-metal seating surfaces.

5. Solder-joint or threaded ends.

G. Copper Tube, Pressure-Seal-Joint Fittings: ASME B16.18, pressure fittings.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC ; ProPress Copper. or a comparable product by one of the following:

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
   c. Mueller Industries, Inc.
   d. NIBCO INC.

2. Fittings for NPS 2 and Smaller: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

3. Fittings for NPS 2-1/2 thru NPS 4Fittings: Stainless steel grip ring and EPDM O-ring seal in each end.

4. Press Ends: Unpressed fitting identification feature to the fitting wall.

5. Sealing Element: EPDM.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4 with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Mechanical-Joint Fittings: ANSI/AWWA C110/A21.10, cement lined fittings with asphalt coating in accordance with ANSI/AWWA C104/A21.4 ductile or gray iron.

B. Push-on-Joint, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4 with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Push-on-Joint Fittings: ANSI/AWWA C110/A21.10, cement lined fittings with asphalt coating in accordance with ANSI/AWWA C104/A21.4 ductile or gray iron.

C. Flanged Ductile-Iron Pipe: ANSI/AWWA C115/A21.51 flanges with pipe barrels conforming to ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4.

1. Standard-Pattern, Flanged Joint Fittings: ANSI/AWWA C110/A21.10, cement lined fittings with asphalt coating in accordance with ANSI/AWWA C104/A21.4 ductile or gray iron and flanges compatible with Class 125 ANSI B16.1 and ANSI A21.15.

D. Plain-End, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 TRANSITION FITTINGS

A. Install transition couplings at joints of piping with small differences in OD's. Refer to transition fitting products specified in Section 22 05 00 “Common Work Results for Plumbing”.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before proceeding with water piping installation, examine conditions existing at Site and notify affected Contractors and Architect of any construction or any other conditions prevailing which prevent, inhibit, or otherwise interfere with water piping installation.

B. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level without pitch and plumb.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. 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.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

Q. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread 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 restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 TRANSITION FITTING INSTALLATION

A. Comply with requirements for transition fittings specified in Section 22 05 00 "Common Work Results for Plumbing."

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

A. Comply with requirements for dielectric fittings specified in Section 22 05 00 "Common Work Results for Plumbing."
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4and Smaller: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. Potable water testing for lead:

1. Coordinate with Owner on any potable water system lead testing previously performed in each building where modifications to the potable water systems are to take place.

B. Perform the following tests and inspections:

1. Lead Testing Prior to Commencing Construction:

a. Collect and test water samples in accordance with NYS Law 10 CRR-NY 67-4.

b. Collect a first-draw sample from a cold-water outlet in the vicinity of the building where work is to be performed.

c. Have samples analyzed for lead content by a State Certified testing lab approved to perform such analyses by the Department's Laboratory Approval Program (ELAP). Submit copy of results to Architect/Engineer as a base line of water quality in the building before construction.

2. Lead Testing After Construction is Complete:

a. Collect and test water samples in accordance with NYS Law 10 CRR-NY 67-4.

b. Collect a first-draw sample from a cold-water outlet in the vicinity of the building where work was performed.

c. Have samples analyzed for lead content by a State Certified testing lab approved to perform such analyses by the Department's Laboratory Approval Program (ELAP). Submit copy of results to Architect/Engineer.

3. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been tested and inspected by the Owner's Representative.

b. During installation, notify Owner's Representative at least two days before inspection must be made. Perform tests specified below in presence of Owner's Representative:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If Owner's Representative finds that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

d. Reports: Prepare inspection reports and have them signed by the Owner's Representative.

4. Above Grade Piping Tests:

a. Initial Test:

1) Do not connect fixtures, equipment and solenoid valves into system during this test.

3) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

4) Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

5) Cap and subject piping to static water pressure of 150 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

6) Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

7) Prepare reports for tests and for corrective action required.

b. Test After Fixtures are Connected:

1) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2) Test system again for 2 hours at 75 psigor prevailing water pressure, whichever is higher.

3) Repair leaks and defects at fixture and equipment connections or at solenoid valves, and retest piping or portion thereof until satisfactory results are obtained.

4) Prepare reports for tests and for corrective action required.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

   b. Fill and isolate system according to either of the following:

      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. After contact period, flush all parts of system with clear water until system tests at no more than 0.2-PPM residual chlorine.

d. Repeat procedures if biological examination shows contamination.

e. Have samples analyzed by a State Certified testing lab. Submit copy of results to Architect/Engineer showing samples test negative for coliform bacteria.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.13 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 4 and larger, shall be one of the following:

1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
2. Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.

D. Aboveground domestic water, building-service piping, NPS 4 and larger.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 2-1/2 and Larger, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

3.14 VALVE SCHEDULE

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping 2 1/2 and larger.
3. Drain Duty: Hose-end drain valves.

C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Flexible connectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for domestic water piping specialties. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Flexible connectors.

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Mason Industries, Inc.
3. Metraflex Company (The).

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

PART 3 - EXECUTION

3.1 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 22 11 19

SECTION 22 11 23.13 – DOMESTIC WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Multiplex, variable-speed booster pumps.

1.3 DEFINITIONS

A. VFC: Variable-frequency controller(s).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. 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.

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-372 for lead-free valve materials for potable-water service.

D. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."
3. UL 778, "Motor-Operated Water Pumps."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 DUPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Grundfos Pumps Corporation U.S.A; Hydro Multi-B or a comparable product by one of the following:

1. Armstrong Pumps, Inc.
2. Bell & Gossett; a Xylem brand.
3. Goulds Water Technology; a Xylem brand.

B. Description: Factory-assembled and -tested, variable speed packaged pumping system with integrated variable frequency drive motors for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

C. Pumps:

1. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, horizontal multistage, separately coupled, overhung-impeller, centrifugal pump.
2. Casing: Steel base and stainless-steel chamber.
3. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
4. Shaft: Stainless steel.
5. Seal: Mechanical.
6. Bearing: Water-lubricated sleeve type.

D. Motors: Integrated variable frequency drive motors, with pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

1. The VFD shall be of the PWM (Pulse Width Modulation) design using current IGBT (Insulated Gate Bipolar Transistor) technology.

2. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.

3. The VFD shall utilize an energy optimization algorithm to minimize energy consumption. The output voltage shall be adjusted in response to the load, independent of speed.

4. The VFD shall automatically reduce the switching frequency and/or the output voltage and frequency to the motor during periods of sustained ambient temperatures that are higher than the normal operating range. The switching frequency shall be reduced before motor speed is reduced.

5. An integral RFI filter shall be standard in the VFD.

6. The VFD shall have a minimum of two skip frequency bands which can be field adjustable.

7. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.

8. The integrated VFD motor shall include protection against input transients, phase imbalance, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. Three-phase integrated VFD motors shall be capable of providing full output voltage and frequency with a voltage imbalance of up to 10%.

9. The integrated VFD motor shall have, as a minimum, the following input/output capabilities:

    a. Speed Reference Signal: 0-10 VDC, 4-20mA
    b. Digital remote on/off
    c. Fault Signal Relay (NC or NO)
    d. Fieldbus communication port (RS485)

10. The motor shall be Totally Enclosed Fan Cooled (TEFC) with a standard NEMA C-Face, Class F insulation with a temperature rise no higher than Class B.

11. The cooling design of the motor and VFD shall be such that a Class B motor temperature rise is not exceeded at full rated load and speed at a minimum switching frequency of 9.0 kHz.

12. Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

E. Piping: Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump.

F. Valves:

1. Shutoff Valves NPS 2 and Smaller: Two-piece, full-port ball valve, in each pump's suction and discharge piping.
2. Shutoff Valves NPS 2-1/2 and Larger: Lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
3. Check Valves NPS 2 and Smaller: Silent type in each pump's discharge piping.
4. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
5. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

G. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

H. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, variable-speed operation, with load control and protection functions and the following features:

1. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions and other devices in controller. Install VFC for pump motors larger than 25 hp in separate panel; same type as motor control panel enclosure.

2. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.

3. Enclosure: NEMA 250, Type 3R.

4. Motor Overload Protection: Overload relay in each phase.

5. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

    a. Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.

6. Designed specifically for control of parallel connect pumps in constant pressure applications.

7. Provides internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

8. Displays the following as status readings from a single display on the controller (this display shall be the default):

    a. Current value of the control parameter, (typically discharge pressure).
    b. Alarm indication.

9. Minimum inputs and outputs:

    a. Two analog inputs (4-20mA or 0-10VDC).
    b. Two digital inputs.
    c. Two digital outputs.

d. Three PTC connections for motor monitoring.
e. Field Service connection to PC for advanced programming and data logging.

10. Minimum field adjustable pump system programming includes the following:

    a. Current setpoint.
    b. Pump control Off/Auto.
    c. System control On/Off.
    d. Alarm reset.

11. Minimum field service connection to PC for advanced pump system programming includes the following:

    a. Water shortage protection (analog or digital).
    b. Transducer Settings (Suction and Discharge Analog supply/range).
    c. PI Controller (Proportional gain and Integral time) settings.
    d. High system pressure indication and shut-down.
    e. Low system pressure indication and shut-down.
    f. Low suction pressure/level shutdown (via digital contact).
    g. Low suction pressure/level warning (via analog signal).
    h. Low suction pressure/level shutdown (via analog signal).
    i. Flow meter settings (if used, analog signal).

12. Capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

13. Emergency / Normal Operation Switches, located on front of panel.

14. Capable of receiving a redundant sensor input to function as a backup to the primary sensor (typically discharge pressure).

15. Ability to communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON), via optional communication expansion card installed inside controller. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

    a. On-off status of each pump.
    b. Alarm status.

16. Pump Operation and Sequencing: Pressure-sensing method.

    a. The system controller shall operate equal capacity variable speed pumps to maintain a constant discharge pressure (system set-point). The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. As flow demand increases the pump speed shall be increased to maintain the system set-point pressure. When the operating pump(s) reach 97% of full speed (adjustable), an additional pump will be started and will increase speed until the system set-point is achieved. When the system pressure is equal to the system set-point all pumps in operation shall reach equal operating speeds. As flow demand decreases the pump speed shall be reduced while system set-point pressure is maintained. When all pumps in operation are running at low speed the system controller shall switch off pumps when fewer pumps are able to maintain system demand.

    b. The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.

    c. All pumps in the system shall alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), the system controller shall have the capability to alternate the pumps every 24 hours, every 48 hours or once per week. The interval and actual time of the pump change-over shall be field adjustable.

I. Base: Corrosion resistant 304 stainless steel with rubber vibration dampers fitted between each pump and base frame to minimize vibration.

J. Pressure Transducer: Type 316 stainless steel, factory installed on the discharge manifold with accuracy of +/- 1.0% full scale and hysteresis and repeatability of no greater than 0.1% full scale. A factory installed pressure switch on the suction manifold for water shortage protection. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

K. Pressure Gauge: Liquid filled, copper alloy bourdon tube pressure gauge, 2.5-inchdiameter stainless-steel case, placed on the suction and discharge manifolds. Gauge accuracy shall be 2/1/2 % and capable of a pressure of 30% above its maximum span without requiring recalibration.

L. Capacities and Characteristics: Refer to Schedule on Drawings.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

    1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Support connected domestic water piping so weight of piping is not supported by booster pumps.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.

1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball valves same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."

2. Install union, flanged, or grooved-joint connections on suction and discharge headers at connection to domestic-water piping.

3. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."

4. Install piping adjacent to booster pumps to allow service and maintenance.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup check according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust booster pumps to function smoothly and lubricate as recommended by manufacturer.
B. Adjust pressure set points.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 22 11 23.13

SECTION 22 12 23 - INDOOR POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pressure type potable-water storage tanks.

1.3 DEFINITIONS

A. HDPE: High-density polyethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including construction details, material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, and furnished specialties water storage tanks.

1. Precharged pressure, potable-water storage tanks

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of potable-water storage tank, from manufacturer.
B. Pressure test reports.
C. Purging and disinfecting activities reports.
D. Lab results for biological testing showing samples negative for coliform bacteria.

1.6 QUALITY ASSURANCE

A. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects," for potable-water storage tanks. Include appropriate NSF marking.

PART 2 - PRODUCTS

2.1 STEEL, PRECHARGED, POTABLE-WATER STORAGE TANKS

A. Steel, Precharged, Bladder, Water Storage Tanks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide AMTROL, Inc; Model No. WX-403C or a comparable product by one of the following:

a. Armstrong Fluid Technology.
b. Taco Comfort Solutions.
c. Wood, John Co.

2. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.

3. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

4. Operation: Factory-installed, butyl-rubber bladder.

B. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure.

C. Tappings: Factory-fabricated stainless steel, welded to tank before testing and labeling.

1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 and Larger: ASME B16.5, flanged.

D. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure gage.

E. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

F. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Coating: Galvanized.

G. Exterior Coating: Manufacturer's standard enamel paint.

2.2 SOURCE QUALITY CONTROL

A. Test and inspect potable-water storage tanks according to the following tests and inspections and prepare test reports:

1. Pressure Testing for ASME-Code, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.

2. Pressure Testing for Non-ASME-Code, Pressure, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks at pressure of 50 psig above system operating pressure, but not less than 150 psig. Fill tanks with water, vent air, pressurize tanks, disconnect test equipment, hold pressure for two hours with no drop in pressure, and check for leaks.

3. Testing for Nonpressure, Potable-Water Storage Tanks: Fill tanks to water operating level to ensure structural integrity and freedom from leaks. Hold water level for two hours with no drop in water level.

B. Repair or replace tanks that fail test with new tanks, and repeat until test is satisfactory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

B. Install the following devices on tanks where indicated:

1. Connections to accessories.

C. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to potable-water storage tanks to allow service and maintenance.

C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

    a. Valves NPS 2 and Smaller: Gate or ball.

    b. Drain Valves: NPS 3/4 gate or ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 22 05 00 "Common Work Results for Plumbing."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following final checks before filling:

1. Verify that air precharge in precharged tanks is correct.

2. Test operation of tank accessories and devices.

3. Verify that pressure relief valves have correct setting.

    a. Manually operate pressure relief valves.
    b. Adjust pressure settings.

B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

A. Clean and disinfect potable-water storage tanks.

B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.

2. Disinfect tanks by one of the following methods:

    a. Fill tanks with water-chlorine solution containing at least 50 ppm of chlorine. Isolate tanks and allow to stand for 24 hours.

b. Fill tanks with water-chlorine solution containing at least 200 ppm of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.

4. Repeat procedures if biological examination shows contamination.

5. Have samples analyzed by a State Certified testing lab. Submit copy of results to Architect/Engineer showing samples test negative for coliform bacteria.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 12 23

SECTION 22 16 16 - FUEL PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fuel dispenser pumps and accessories.

1.3 DEFINITIONS

A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Fuel dispenser pumps.
2. Swivel breakaway combinations.
3. Fuel dispenser hoses.
4. Fuel dispenser nozzles.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel pumps and fuel maintenance systems to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.
B. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

2.2 FUEL DISPENSER PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Fill-Rite Model NX-25-120NB-AC or a comparable product by one of the following:

1. Bennett Pump Company.
2. Gilbarco Inc.
3. Tokheim.

B. Description: Self-contained, tank mounted, one hose single product, enhanced capacity, electronic meter.

C. Performance: 25 gpm.

D. Compatibility: UL listed for dispensing low viscosity petroleum fuels – diesel; biodiesel blends up to 20%, gasoline, including oxygenated blends.

E. Body Construction: Bung mounted, cast iron pump housing with 20 x 20 mesh strainer. Nozzle boot to be pad lockable to not allow nozzle removal or pump power activation.

F. Meter: UL listed, nutating disc measuring system with 7 digit, non-resettable totalizer and 4 digit resettable counter. Unit powered by (2) AA batteries.

G. Inlet Connection: 2 NPT.

H. Pumping Unit: Rotary vane type pumping unit with anti-siphon device and suction strainer at inlet connection.

I. Motor: 1/3 HP continuous duty with thermal overload protection.

J. Discharge: 1 NPT.

K. Nozzle: 1 NPT nozzle, ultra-hi flow nozzle with automatic shutoff.

L. Hose: 1 NPT X 18 feet, static discharge hose

M. Electrical Characteristics:

1. Motor Horsepower: 1/3.
2. Volts: 120.
3. Phase: Single.
4. Hertz: 60.
5. Full-Load Amperes: 4.9 amps

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel pumps to verify actual locations of pump connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.3 FUEL PUMP INSTALLATION

A. Submersible Pumps:

1. Suspend pumps from supply piping and anchored to bottom of tank.

B. Transfer Pumps:

1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
2. Set pumps on and anchor to concrete base.
3. Pump Mounting: Mount pump directly on fuel tank per manufacturer’s instructions.

C. Install mechanical leak-detector valves at pump discharge.

D. Install check valve on discharge of simplex fuel pumps.

E. Install suction piping with minimum fittings and change of direction.

3.4 LABELING AND IDENTIFYING

A. Install nameplates and signs on each fuel pump. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Start fuel transfer pumps to verify for proper operation of pump, and check for leaks.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Fuel pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel pumps.

END OF SECTION 22 16 16

SECTION 22 16 23 - NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping and tubing joining materials.
3. Valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Install gas equipment, piping materials and provide testing in accordance with Fuel Gas Code of New York State, applicable American National Standards Institute (ANSI) code and NFPA 54 - National Fuel Gas Code, and rules and regulations of local gas company.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Refer to “Existing Utility Interruptions” paragraph of Section 01 10 00 “Project Summary-Project Schedule” for requirements associated with interrupting the existing natural gas supply to facilities occupied by the Owner.

1.8 COORDINATION

A. Coordinate requirements for piping painting and identification for natural-gas piping. Comply with requirements in Section 22 05 53 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 54 the International Fuel Gas Code.

B. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

C. Natural-Gas System Pressure within Buildings:

1. Single Pressure: 0.5 psig or less.

D. 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.

2.3 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

3. Mechanical Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Dresser Piping Specialties; Division of Dresser, Inc.
2) Smith-Blair, Inc.

b. Stainless steel flanges and tube with epoxy finish.

c. NBR seals.

d. Stainless steel bolts, washers, and nuts.

e. Coupling is to be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

f. Steel body couplings installed underground on plastic pipe are to be factory equipped with anode.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.5 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.

2. Threaded Ends: Comply with ASME B1.20.1.

3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.

4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.

5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.

B. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Lee Brass Company.
b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B584.

3. Plug: Bronze.

4. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.

5. Operator: Square head or lug type with tamperproof feature where indicated.

6. Pressure Class: 125 psig.

7. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Refer to Section 22 05 00 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

2.7 LABELING AND IDENTIFYING

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Paint: Refer to Section 09 91 00 "Painting" for interior and Section 09 96 00 “High-Performance Coatings” for exterior natural-gas piping paint materials and basic installation requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to Fuel Gas Code of New York State to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with Fuel Gas Code of New York State requirements for prevention of accidental ignition.

3.3 INSTALLATION OF OUTDOOR PIPING

A. Comply with Fuel Gas Code of New York State for installation and purging of natural-gas piping.
B. Install fittings for changes in direction and branch connections.

3.4 INSTALLATION OF VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.8 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

3.9 PAINTING

A. Comply with requirements in Section 09 96 00 “High-Performance Coatings” for exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Test, inspect, and purge natural gas according to Fuel Gas Code of New York State and authorities having jurisdiction.

a. Isolate appliances and equipment prior to conducting pressure test.

b. The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.

c. Leave pipe joints, including welds, exposed for examination during the test.

d. Isolate the source of pressure before the pressure tests are made.

e. Measure test pressure with a manometer or with a pressure-measuring device designed and calibrated to read, record or indicate a pressure loss caused by leakage during the pressure test period. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.

f. Pressure test piping to no less than 1-1/2 times the proposed maximum working pressure, but not less than 30-psig irrespective of delivered gas pressure, for a duration of 2 hours.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping NPS 2 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. Bronze plug valve.

END OF SECTION 22 16 23

SECTION 22 17 16 - ABOVEGROUND FUEL STORAGE TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulated, steel, fuel ASTs.
2. AST Accessories.

1.3 DEFINITIONS

A. AST: Aboveground storage tank.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, and dimensions of individual components and profiles, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each type of product.

1. 1,000 insulated, steel, AST.
2. Tank gauge.
3. Normal vent primary tank.
4. Primary tank emergency vent.
5. Secondary tank emergency vent.
6. Spill container.
7. Dust cap.
8. Inlet adapter.
9. Overfill prevention valve.
10. Drop tube.

B. Shop Drawings:

1. Include plans, elevations, sections, and ballast pads and anchors, and lifting or supporting points.
2. Indicate dimensions, components, and location and size of each field connection.
3. Shop Drawing Scale: 1/4 inch per foot.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.
B. Welding certificates.
C. Field quality-control reports.
D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. NYSDEC Permit Drawing: Prepare Project Record Drawings in compliance with Section 01 78 39 "Project Record Documents" and as required by 6NYCRR Part 613, including, but not limited to:

   1. An accurate drawing showing location and notation of:

      a. Each AST and associated piping, include tank capacity, product stored and registration identification number.
      b. Fill ports.
      c. Dispensing equipment.
      d. Check valves.
      e. North arrow.
      f. Drawing scale.

B. A signed statement of certification by the Installer that the installation meets all applicable State, Federal and Local Regulations.

C. Completed manufacturer's installation checklist showing that the AST was installed in accordance with the manufacturer's requirements.

D. Operation and Maintenance Data: For fuel equipment and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Aboveground Fuel Storage Tanks: Comply with requirements of the EPA, State and local authorities having jurisdiction, including recording fuel storage tanks.

   1. Materials, Installation and Workmanship:

      a. Comply with requirements of New York State Petroleum Bulk Storage Code (6NYCRR Part 613).
      b. Comply with requirements of NFPA Flammable and Combustible Liquids Code (NFPA #30, #30A, #31 and #17, latest editions).
      c. Comply with requirements of API Recommended Practice 1615, April 2011.
      d. Comply with requirements of PEI Recommended Practice 100, 2011 edition.
      e. Comply with requirements of 1997 Uniform Fire Code (UFC) "Protected" AST criteria as per Appendix II-F, including ballistics protection.

2. Electrical Wiring: Comply with requirements of National Electrical Code (NEC), Article 514.

3. Tanks: Manufactured in compliance with Underwriters Laboratories Standards 142 Standard for Steel Aboveground Tanks for Flammable Liquids. A UL Label shall be attached to each tank.

4. Fill ports: Color code in accordance with API Recommended Practice 1637.

B. EPA Compliance: Comply with EPA and state and local authorities having jurisdiction. Include recording of fuel storage tanks and monitoring of tanks.

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

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel storage tanks that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:

1) Structural failures including cracking, breakup, and collapse.

b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INSULATED, STEEL, FUEL AST

A. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank & Manufacturing Company, Inc.; UL-2085 Fireguard® Thermally Protected Steel Storage Tank with integral overfill protection chamber or comparable product by one of the following:

1. Ace Tank & Equipment Company.
2. Modern Welding Company, Inc.
3. Newberry Tanks & Equipment, LLC.
4. Stanwade Metal Products, Inc.
5. Steel Tank & Fabricating Co., Inc.
6. We-Mac Manufacturing, Inc.

B. Description: UL 142, UL 2085, and STI F941, thermally insulated and fire-resistant, double-wall, horizontal, steel tank; with primary- and secondary-containment chambers, insulation and with interstitial space and impervious steel outerwall.

C. Construction: Fabricated per UL-142 with continuously lap welded, carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085 and provides a minimum 2-hour fire rating.

1. Secondary Containment: 20 percent of primary tank capacity.

2. Insulation: Factory installed 3 inch porous, lightweight monolithic thermal insulation within the interstitial space of the inner and outer tanks in accordance with ASTM C-332 and C-495, allowing liquid to migrate through to monitoring point.

3. Finish: Factory commercial blast cleaning of outer tank in accordance with SSPC-SP-6 and factory applied white finish paint system 5-7 DFT.

D. Capacities and Characteristics:

1. Nominal Capacity: 1,000 gal.
2. Diameter: 4 feet.
3. Overall Length: 11'-3" feet.

E. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.

1. Connection Sizes:

a. Fill Line: 4 NPS.
b. Normal Vent Primary Tank: 2 NPS.
c. Outlet: 2 NPS.
d. Return: 4 NPS.
e. Interstitial Monitoring: 2 NPS.
f. Liquid Level Gage: 2 NPS.
g. Primary Tank Emergency Vent: 4 NPS.
h. Secondary Tank Emergency Vent: 6 NPS.

F. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.

G. Saddles: Factory primed and painted welded on saddles supplied as part of the complete UL assembly.

H. Lifting Lugs: For handling and installation.

I. Tank Identification:

1. Provide stencil, label or plate on exterior of tank which includes the following;

a. Name of manufacturer

b. Manufacturer's statement "This tank conforms with 6 NYCRR Part 614"

c. Description of standard of design by which tank was manufactured.

d. Lists of petroleum products and percentages of volume of petroleum additives that may be stored permanently and compatibility within tank or reference to list available from manufacturer that identifies products compatible with all tank materials.

e. Year in which tank was manufactured.

f. Unique manufacturer's identification number.

g. Dimensions, model number of tank, design and working capacity

2. Certification Plate: Underwriters Laboratories label "Insulated Secondary Containment Aboveground Tank for Flammable Liquids." affixed to each tank.

2.2 AST ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide fuel oil specialties manufactured by OPW; A Dover Company or comparable product by one of the following:

1. Franklin Fueling Systems.
2. Morrison Bros. Co.

B. Atmospheric primary tank vent: 2-inchsize, vertical type aluminum body with 40-mesh brass screen; similar to "Model No. 23."

C. Primary tank emergency vent: 4-inchsize, vertical type aluminum body with zinc plated steel shaft and weighted cast iron lid with powder-coated finish; similar to "Model No. 301."

D. Secondary tank emergency vent: 6-inchsize, vertical type aluminum body with zinc plated steel shaft and weighted cast iron lid with powder-coated finish; similar to "Model No. 301."

E. Remote fill spill container: 12-gauge, powder steel coated construction with 15- gallon spill capacity, adjustable legs and base drain valve; similar to "Model No. 211-RMOT series."

F. Inlet adapter: 3-inchsize, stainless steel, poppeted remote fill adapter with Viton seal; similar to "Model No. 633AST."

G. Dust cap: 3-inchsize, aluminum cap with Buna-N seal; similar to "Model No. 634B."

H. Overfill prevention valve:

1. 2-inch UL listed, cast aluminum AST overfill prevention valve with integral air vents, closed-cell nitrile float with stainless steel cam designed to install in a 4-inch threaded tank opening; similar to Model No. "61fSTOP-1000."

2. 2-inch extruded aluminum drop tube design to install on the bottom of the overfill prevention valve to allow submerged tank filling; similar to Model No. "61FT."

I. Drop Tubes: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle; similar to "Model #61T."

J. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

K. Breakaway coupling: UL listed, aluminum body, nylon sleeve with stainless steel spring; similar to “Model #68EZR”

2.3 SHOP PAINTING OF AST

A. Prepare exterior steel surface of AST and tank supports.
B. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3.
C. After cleaning, remove dust or residue from cleaned surfaces.
D. If surface develops rust before prime coat is applied, repeat surface preparation.
E. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.
F. Apply manufacturer's standard two-component, epoxy finish coats.

2.4 LEAK-DETECTION SYSTEM

A. Subject to compliance with requirements, provide OMNTEC Manufacturing, Inc.; Model No. LU3-SP1 Series as indicated or comparable product by one of the following:

1. Franklin Fueling Systems.
2. Highland Tank & Manufacturing Company, Inc.
3. Veeder-Root Company (The).

B. Continuous leak and overfill detection system utilizing electro-optic technology and float technology with probes, other sensors and remote alarm panel for fuel storage tanks and fuel piping.

C. Cable and Sensor System: Comply with UL 1238.

D. Remote Annunciator Panel: NEMA 4X enclosure with 120dB horn and strobe light for high level alarm, auto time-out and horn silence button. Similar to “RAS-NYS” by OMNTEC Mfg., Inc.

E. Controls: Electrical, operating on 120-V ac.

F. System Probes:

1. Annular Space Probes: UL listed, non-product distinguishing interstitial sensor; similar to “LWF-* (* denotes tank diameter)” by OMNTEC MFG., Inc.

2. High/Low level Alarm Sensor: U.L. listed, intrinsically safe Class I, Group D hazardous locations, dual level liquid optic sensor for high and low levels; Similar to “L-2” by OMNTEC Mfg., Inc.

3. All wiring and cables run in rigid conduit with watertight junction boxes and cable manifolds as required. All penetrations of piping containment chamber sealed watertight.

2.5 LABELING AND IDENTIFYING

A. Color coding: Refer to Section 09 96 00 “High Performance Coatings” and Part 3 below for high performance coating materials and basic installation requirements. Fill port color selections to match API Recommended Practice 1637 or Authority Having Jurisdiction.

2.6 SOURCE QUALITY CONTROL

A. Pressure test and inspect fuel storage tanks, after fabrication and before shipment, according to ASME and the following:

1. Horizontal, Concrete-Vaulted and Insulated, Steel ASTs: UL 142 and UL 2085.

B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for aboveground fuel storage tanks to verify actual locations.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 FUEL TANK REMOVALS

A. Comply with requirements in Section 02 65 00 “Storage Tank Permanent Closure" for fuel tank removals.

3.3 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.
B. Allow for cast-in-place, concrete base.

3.4 FUEL AST INSTALLATION

A. Install tank bases and supports.

B. Concrete Bases: Anchor AST to concrete base according to equipment manufacturer's written instructions.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Use 4000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

C. Connect piping and vent fittings.

D. Install ground connections.

E. Install tank leak-detection and monitoring devices.

F. Install steel ASTs according to STI R912.

G. Install insulated and concrete-vaulted, steel ASTs according to STI R942.

3.5 LEAK-DETECTION SYSTEM INSTALLATION

A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.

1. Double-Wall, Fuel Storage Tanks: Install probes in interstitial space.
2. Install liquid-level gage.

B. Provide waterproof remote overfill alarm box with horn and flashing light and overfill sign. Install overfill sign on exterior wall 10 feet above grade or where shown on Drawings. Mount overfill acknowledgment switch on exterior wall 4 feet above grade near fuel tank as shown on Drawings.

C. Install monitor cables in 3/4-inchrigid conduit from monitor panel to leak detection probes and to tank level sensor in tank. Provide sealing fittings in conduit at exterior building wall penetrations.

D. Provide extractor manhole at interstitial space probe for access to monitor cable connections.

3.6 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Permanently mark all fill ports to identify product inside tank in manner consistent with color and symbol code of American Petroleum Institute as follows:

1. #2 fuel oil.....Green.
2. Diesel.....Yellow.
3. Lower unleaded gasoline .....White with black cross.
4. Middle unleaded gasoline .....Blue with white cross.
5. Higher unleaded gasoline.....Red with white cross.

C. Verify with Owner fuel types prior to color-coding of fill port.

D. Use following symbols:

1. Circle for gasoline products and vapor recovery lines.
2. Hexagon for other distillates.
3. Paint black border around white symbol and white field for field products containing extenders such as alcohol.

3.7 FIELD PAINTING OF AST

A. Prepare and touch up damaged exterior surface of AST and supports as specified in "Shop Painting of AST" Article.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

a. Double-Wall Tanks:

1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.

b. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.

c. Maintain the test pressure for one hour.

C. ASTs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 22 17 16

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and all Division 01 Sections, apply to this Section and to all of Division 23.

1.2 SUMMARY

A. This Section includes the following:

1. Definitions, references, and abbreviations.
2. General regulatory requirements.
3. General requirements regarding site/field conditions including existing conditions and field measurements.
4. Sequencing and scheduling including coordination.
5. Definition of design equipment and procedures for consideration of specified equivalents, proposed equivalents, or substitutions.
6. HVAC demolition.
7. Equipment installation requirements common to equipment sections.
8. Minimum material requirements and equipment verification.
9. Electrical components for HVAC Work
10. Mechanical penetrations, waterproofing, and sealants.
11. Fire-stopping
12. Access doors
13. Painting and finishing.
14. General requirements for demonstration of completed systems

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. "Design Equipment", "Design Make", "Basis of Design", and similar terms: Equipment, specified in Technical Specification Section or on Contract Drawings using applicable manufacturer's designation, that forms the basis for performance requirements, physical dimensions, configuration, and similar aspects used in the design of this Project including (but not limited to) physical configuration of surrounding construction and location of connections to other components.

G. Specified Equivalents: Products identified in Technical Specification Section that may provide performance complying with specified requirements but may not have the same arrangement, configuration, size, construction, or other aspects as the specified Design Equipment. Refer to Section 00 21 13 - Instructions to Bidders, and Section 01 25 00 – Substitution Procedures for additional information and requirements regarding equivalents and substitutions.

H. "Equivalents", "Proposed Equivalents", "Proposed Products" and similar terms: These terms may be used interchangeably and mean the same thing: Products NOT identified in Technical Specification Section that the Contractor proposes in accordance with Section 00 21 13 - Instructions to Bidders and Section 01 25 00 – Substitution Procedures.

I. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor, all in accordance with Section 01 25 00 – Substitution Procedures.

J. Heating Work: Refers to Heating, Ventilating and Air Conditioning Systems and Equipment where used in technical specification sections of Division 23.

K. Plumbing Work: Refers to Plumbing and Gas Fitting Work where used in technical specification sections of Division 22.

1.4 ABBREVIATIONS

A. Abbreviations: Reference to technical society, organization, body or section made in Division 23 in accordance with the following abbreviations:

1.	AIA	American Institute of Architects
2.	ADA	Americans with Disabilities Act.
3.	AMCA	Air Movement and Control Association International, Inc.
4.	ANSI	American National Standards Institute
5.	ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
6.	ASME	American Society of Mechanical Engineers International
7.	ASTM	American Society for Testing and Materials International
8.	AWS	American Welding Society
9.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
10.	NEC	National Electric Code
11.	NEMA	National Electrical Manufacturers Association
12.	NFPA	National Fire Protection Association
13.	NYBFU	New York Board of Fire Underwriters

14. SMACNA Sheet Metal and Air Conditioning Contractors National Association
15. UL Underwriters Laboratories Inc.

1.5 SYSTEM DESCRIPTION

A. Provide complete systems, properly connected, tested, balanced, adjusted, and ready for operation, including all necessary and required controls, safeties, details and accessories, including (but not limited to):

1. Demolition and removals required for equipment and system installation.
2. Piping systems and related equipment.
3. Refrigeration systems and related equipment.
4. Ventilation systems and related equipment.
5. Support Systems and related equipment.
6. Insulation Systems and related equipment.
7. Miscellaneous items required for equipment and system installation.
8. Controls and electrical control wiring to equipment furnished in this contract.
9. Electrical power wiring to equipment furnished in this contract, where not covered elsewhere.

B. HEATING WORK DRAWINGS ARE DIAGRAMMATIC. Do not infer that Drawings show level of detail indicating every offset, elbow, union, fitting, elevation or aspect ratio changes, or other details required for complete installation.

1. Provide all required fittings, offsets, elevation changes, dampers, controls, components, and similar items not indicated on Drawings, as required for a complete properly operational system.

1.6 SUBMITTALS

A. General Division 23 submittal requirements:

1. Procedural Requirements: Comply with requirements of Section 01 33 00 - Submittals and as modified below.

a. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 of product specification, and will be installed as specified in Part 3, and only where allowed as such in submittal portion of product specification, then submit “As-Specified Verification Form” (attached to Section 01 33 00 - Submittals) in lieu of “Product Data” identified.

b. Do not use “As Specified Verification Form” unless specifically indicated in detailed product specification.

c. Equivalent Products or Substitutions: If product to be incorporated into Project is <u>not</u> specified by name and product designation in Part 2 below, comply with all Product Data requirements specified.

2. Product Data: Submit Product Data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction, and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.

    a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under same cover sheet.

    b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in "Manufacturers" in Part 2 - Products below.

3. Coordination Drawings: Prepare Coordination Drawings in timely manner to comply with overall construction schedule. Refer to Sections 01 31 00 and 01 33 00 for more details.

    a. Prepare drawings coordinating HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, building systems, existing construction, etc. Provide additional details and sections, as required for clarity, at all places of potential conflict.

    b. Deliver Coordination Drawings in accordance with requirements specified in Section 01 31 00. Indicate areas of conflicts between HVAC systems and other building components by highlighting locations on drawings and separately listing.

    c. Reposition proposed locations of HVAC systems as required to work within project constraints. Adjust exact size, aspect ratio, location and offsets of ducts and pipes as required. Achieve as specified and other reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.

    d. Review of Coordination Drawings in accordance with Section 01 31 00 does not relieve Contractor from responsibility for coordinating HVAC systems with Project work, nor does it authorize extra cost, omission or deviation from Contract Document requirements. Costs arising from errors or omissions in Coordination Drawings shall be borne by Contractor.

    e. Review Coordination Drawings and compare them with all other drawings to verify that all Work can be installed without interference. Notify Owner's Project Representative in case of unresolved interferences prior to installation of any work. Revise Coordination Drawings as required to eliminate installation interferences upon direction of Architect.

4. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.

5. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space, and other pertinent revisions to arrangement and configuration shown in Contract Documents.

6. Closeout Information, for inclusion in Operations and Maintenance Manual:

   a. Approved submittals.

      1) If "As-Specified Verification Form" submittal is approved, also include product data as specified in technical section for all components used.

   b. Include all information required in Section 01 78 23 – Operation and Maintenance Data.

   c. Include all other closeout information required by the individual technical specification sections.

B. Shop Drawings: Include dimensioned plans, sections, and attachments to other work for concrete bases.

C. Welding Quality Control Submittals

1. When welded or brazed work is required or proposed as a part of this project, submit following for approval before beginning any welding or brazing work:

   a. Welding and Brazing Procedure Qualification: Prepare and submit for approval welding and brazing procedure qualification specification qualifying all proposed procedures as specified in Quality Assurance below with copies of all back-up data.

   b. Welders' and Brazers' Certification: Submit for approval certification that each proposed welder, welding operator, brazer, or brazing operator has been qualified in all procedures proposed for that worker as specified in Quality Assurance below with copies of all back-up data.

D. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1. Power Train Accessories
2. Sealants
3. Fire-stopping.
4. Access doors.
5. Painting and finishing.

E. Samples:

1. Submit color chart with paint manufacturer's color samples for final color selections prior to beginning painting. Comply with additional requirements for color selection samples specified in Division 09.

F. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittals.

a. If "As-Specified Verification Form" submittal is approved, also include product data for all components used.

2. Include all information required in Section 01 78 23 – Operation and Maintenance Data.

3. Letters on manufacturer's letterhead from equipment manufacturers certifying that their equipment and systems have been installed in strict accordance with manufacturer's recommendations, properly aligned and adjusted, tested, lubricated, wired, balanced, etc.

4. Lubrication and Filter charts as described below.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements

1. Comply with applicable requirements of all Federal, New York State, and Local Building, Health, Mechanical, Plumbing and Electrical Codes, Laws, Ordinances and Regulations, including (but not limited to):

a. Building Code of New York State
b. Mechanical Code of New York State
c. Fire Code of New York State
d. Energy Conservation Construction Code of New York State
e. New York State Education Department Manual of Planning Standards
f. In event of a conflict between the Codes identified above and Contract Documents, comply with more stringent requirement.

2. Comply with applicable requirements of NFPA, utility company regulations, and following standards:

a. Provide Underwriters Laboratories (UL) labels on all electrical materials carrying 50 volts or more.
b. Provide refrigeration equipment complying with Safety Code for Mechanical Refrigeration (ASHRAE Standard 15 - and ANSI Refrigeration Safety Code B9.1).

B. Field Samples and Mock-ups:

1. Provide Field Samples and Mock-ups as indicated below. General requirements for all Field Samples and Mock-ups include:

a. Where possible, create Field Samples and Mock-ups as the first installation of a series of similar installations, intended to remain in place as part of the completed Work.

b. Schedule visit by A/E and CM at least two weeks before mock-up completion for review and approval of standard of construction.

c. Modify as required for approval in accordance with Contract Documents.

d. Obtain A/E approval before starting general installations.

e. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless A/E specifically approves such deviations in writing.

f. Maintain samples and mockups during construction in an undisturbed condition as a standard for judging the completed Work.

2. Mechanical Insulation Installation: Construct one complete field sample for each type of insulation system indicated below to demonstrate quality of insulation application and finishes. Use materials indicated for the completed Work. Install mockups in the location indicated or, if not indicated, coordinate specific locations with CM and Architect in general in conveniently accessed locations in mechanical spaces where insulation will remain exposed for continued review and can remain as part of the finished Work. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, jackets, and all other associated components. Remove labeling and cutaway sections of mockups when directed and complete insulation at mock-up per specifications and as required integrating with balance of job.

a. Ductwork Insulation Mock-ups:

1) One 10-foot section each of rectangular and round straight duct.
2) One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
3) One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
4) One rectangular to round transition fitting.
5) Four support hangers for round and rectangular ductwork.
6) One roof deck penetration at RTU or PRE.
7) Exterior duct insulation examples.

C. Certifications: Obtain and pay for all necessary inspections and certificates from all applicable agencies. Perform all required tests in accordance with regulation of agency having jurisdiction. Submit certificates of approval prior to Final Completion as defined in Section 01 77 00 – Closeout Procedures. Submit certificates of approval prior to request for final acceptance of Contract.

D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Welding Quality Control for General Construction and Support Work:

1. This paragraph refers to qualifications for General Construction and Support Work welding only. Qualify welders, brazers, and any welding or brazing procedure to be used on piping for this Project in accordance with ASME "Boiler and Pressure Vessel Code", Section IX, as specified and detailed in Section 23 21 13 - HYDRONIC PIPING.

2. Welding and Brazing Procedure Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel." Qualification may by made by technically competent group or agency (subject to approval) meeting the following conditions:

   a. Group or agency qualifying the procedure meets all procedure qualification requirements of AWS D1.1/D1.1M, "Structural Welding Code - Steel.".

   b. Contractor accepts full responsibility for procedure qualified.

   c. Contractor has qualified at least one welder or welding operator using procedure qualified and provides record of qualification.

   d. Contractor accepts full responsibility for qualified procedures by signing related qualification records with procedure and performance qualifications including all dates, results, and associated data.

3. Welders' and Brazers' Qualifications: Ensure that all welders, welding operators, brazers, or brazing operators employed for this project are qualified for all welding and brazing procedures, proposed as part of this Project, in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel.". Qualification by previous employer or technically competent group or agency (subject to approval) may be acceptable if following information is included:

   a. Documentation that the previous qualification was for essentially the same procedures proposed and was in full accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel.".

   b. Copy of performance qualification testing record showing who qualified the worker, date of qualification, and work history record showing continuous performance to maintain qualification.

4. Weld and Braze Qualification Records: Maintain and sign certified records of approved procedures used and approved qualified workers employed for welded and brazed joints performed as a part of Prime Contract. Ensure all welding and brazing work can be traced to a specific procedure and welder.

5. Inspection and Examination by Owner, Remedy by Contractor: Owner reserves right to examine, inspect, and test all piping using visual, radiographic, or other recognized testing methods to determine compliance with specified quality control requirements and requirements of applicable regulatory agencies.

    a. Cost of Owner's testing of acceptable installation provided at Owner's expense.
    b. Repair piping installations not passing Owner's quality inspection testing using approved method or replace at no additional cost.
    c. Cost of initial testing of piping not conforming to specified requirements and any retesting of repairs or replacement work shall be deducted from Contract Sum.

F. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Ship materials in manufacturer's containers, fully identified with manufacture's name, trade name, type, class, style, model, grade, size and color.

B. Storage and Protection

1. Store materials, equipment, fixtures, pipe, fittings, attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.

2. Furnish extra materials identified in technical sections, in original manufacturer's containers and packaging, to Owner at location identified during Preconstruction Conference. Obtain receipt from Owner upon delivery of extra materials and send copy of receipt to Architect.

3. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.

1.9 PROJECT/SITE CONDITIONS

A. Field Measurements

1. DO NOT SCALE DRAWINGS: Refer to Architectural and Structural drawings for dimensions and details, and verify measurements in field before proceeding.

2. Install all items with proper provision for removal and access to coil bundles, boiler tubes, belts, valves, traps, and similar components.

3. Layout of equipment, piping, and similar components in Drawings is diagrammatic. Review Drawings in the field, identify interference with other construction and verify dimensions at Site prior to beginning installation.

a. Obtain exact size and location of all items and openings and confirm all existing conditions in field. Review Shop Drawings of all Contracts.

b. Coordinate all Heating Work that interferes with other construction with other responsible Contractor.

c. Obtain exact location and roughing requirements for all equipment furnished by others, but installed by this Contractor before roughing. Owner reserves right to make reasonable changes prior to "roughing-in" without increase in Contract Sum.

4. Report any conflicts to Architect in writing before beginning installation.

1.10 SEQUENCING AND SCHEDULING

A. Perform all Heating Work in cooperation with Owner, Architect, Construction Manager, and all Contractors on this Project, and other separate Contractors at the Site.

1. Coordinate all Heating Work with construction schedule requirements in Division 01
2. Coordinate all submittals with the construction schedule and with requirements and schedules contained in Section 01 33 00 – Submittals Procedures.
3. Immediately report any delays in receipt of materials required for Heating Work including circumstances causing delays.

B. Existing Construction: Provide openings, chases, recesses, lintels and bucks required for admission of Heating Work, unless otherwise noted. Do not cut waterproofed floors or walls for admission of equipment or materials without written permission. Do not pierce structural members without written permission.

C. Supports for Heating Work: Provide anchor bolts required supporting or securing Heating Work. Locate settings and check locations as construction progresses. Provide templates or holding fixtures as required to maintain proper accuracy.

D. Cutting and Patching: Bear expense of cutting, patching, repairing or replacing of work of all Contracts required due to fault, error or damage by contractor responsible for Heating Work, unless otherwise specified in Contract Documents. Employ and pay Prime Contractor involved, or if there is no associated Prime Contractor, employ and pay qualified subcontractor as required for corrective work.

E. Refer to Division 01 for cooperation between Contractors. Prior to start of construction:

1. Obtain from Contract Drawings or Architect, exact location of items and openings in construction. Conform to existing conditions in field.

2. Review Shop Drawings of all Contracts.

3. If conflict occurs between Contract Drawings, advise Architect in writing before beginning installation and comply with Architect's directions.

4. Obtain exact location and roughing requirements for equipment furnished by other Contractor or by Owner, but installed by Contractor responsible for Heating Work before beginning roughing.

1.11 COORDINATION

A. Pre-Installation Conference:

1. Attend pre-installation conference. Arrange for all subcontractors to be in attendance.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

E. Coordinate Heating Work with plumbing systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, and building systems. Verify that Work of all Contractors can be installed without interference with Heating Work.

F. Notify Architect in case of unresolved interferences prior to installation of Heating Work.

G. Adjust exact size, location and offsets of exposed HVAC components to achieve reasonable appearance objectives without increase in Contract Sum.

H. Testing and Balancing: Cooperate with contractor responsible for Testing and Balancing work as required ensuring complete and proper testing, balancing and adjustment of air and water systems. Refer to Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC, for details.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Equipment – Provide as specified and scheduled with all options as required for full compliance.

B. Specified Equivalents - If Specified Equivalents (refer to "Definitions" in Part 1 above) are proposed, comply with following requirements:

1. Submit "Specified Equivalent Drawings" as specified in "Submittals" in Part 1 above.

a. Provide required changes in design and adjacent construction or equipment at no increase in Contract Sum.

1) Where required, provide larger motors, equipment, additional control devices, valves, fittings, and other miscellaneous equipment necessary for proper operation and provide proper location of roughing and connections to other Contractors.

2) Provide additional motors, starters, power, wiring, and control wiring required.

3) Provide revisions to equipment, wiring, support structure, controls, valves, fittings, and other miscellaneous equipment.

4) Additional Architectural and Engineering work, coordination, and documentation.

b. If proposed arrangement for Specified Equivalent is rejected, revise to be compliant and resubmit or submit Basis-of-Design Equipment.

2. Submit "Specified Equivalent Product Data" as specified in "Submittals" in Part 1 above to demonstrate that proposed Specified Equivalent is equal to or better than Basis-of-Design Equipment with respect to all performance characteristics, including but not limited to durability, individual equipment operating costs, entire interrelated system operating costs, service access, noise levels, vibration levels, compatibility with Owner's other existing equipment to minimize parts inventory, aesthetics where applicable, and similar characteristics.

3. Do not assume that approval of a specified equivalent submittal implies approval of the installed product. Correct all deviations uncovered during construction and warrantee period that result in or are caused by any lower performance characteristic than the specified Basis of Design equipment.

C. Proposed Equivalents and Substitutions: In addition to requirements described elsewhere in these Contract Documents, all proposed equivalent and substitution products being considered shall be subject to the Specified Equivalent requirements listed above.

2.2 MATERIALS

A. Minimum Material Requirements:

1. Construct potable water systems and equipment according to Plumbing Code of New York State.

2. Provide electrical equipment and systems meeting UL standards and requirements of NEC.

3. Provide UL label on all equipment and material with listing service.

4. Material Flammability:

a. Flame spread rating of 25 or less.
b. Smoke developed rating of 50 or less.

5. Equipment Verification: Carefully check manufacturer's drawings and specifications as they affect their particular equipment; follow factory instructions for roughing, installation, connection, filling, lubrication, testing, balancing, adjusting, alignment, wiring, and start-up operation.

2.3 MOTOR POWER TRAIN ACCESSORIES

A. For all new motor installations, whether in new equipment or installed as replacement motors, provide accessories listed below as required for a complete new drive system.

B. Independently Mounted Direct Driven Load Motor Couplings: Interlocking machined and balanced steel spider locked Molded rubber insert and capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. Include EPDM coupling sleeve for variable-speed applications.

2.4 SEALANTS

A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants", and also with requirements for Air Duct sealants in Section 23 31 00 – Ductwork.

B. Provide premium products specified for each application as appropriate.

2.5 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.6 PAINT AND FINISHES

A. Refer to Division 09 for paint and finish product specifications.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Execution" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material at point of continued use or as otherwise specifically indicated.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap all duct ends with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and remove equipment and all associated accessories. Plug, cap, seal, and otherwise patch to match as required.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, protect, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational. Document any existing damage before removals.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. Disposition of Removed Components:

1. All material and equipment shown on the drawings to be removed during project Work that is not indicated on the drawings as being either reused or turned over to the Owner becomes the Contractor’s property as a part of the project including salvage value and legal disposal cost complete.

2. For components that become the Contractor’s property through this removal process: Confirm transfer of ownership in writing then promptly remove from the site and legally process.

3. For components indicated on the drawings to be turned over to the Owner: deliver to a project site location designated by the Owner.

4. For components indicated on the drawings to be reused: carefully remove, protect, and store until appropriate time for re-installation. Document any pre-existing damage prior to removals.

5. For pipe and tubing indicated to be reused, reuse only those portions of pipe, tubing, and associated fitting assemblies where they are direct replacements of the as specified and as shown new piping assemblies. Valves, strainers, other piping specialties, and insulation shall not be re-used unless specifically indicated on drawings.

3.2 EXISTING CONDITIONS

A. Reuse materials and equipment only as indicated on Drawings. Furnish new equipment and materials in conformance with Contract Documents for all Heating Work, including any material, operation, method or device mentioned, listed or noted within Division 23 Sections, unless reuse is specifically indicated, or unless specified as furnished or installed by Owner, all Contractors, or others.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is otherwise made unserviceable by adjacent or associated work or error, remove damaged or unserviceable portions and replace with new products of equal capacity and quality. Verify, document, and confirm pre-existing damage with Owner and Architect before beginning work.

3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Ensure each equipment manufacturer:

1. Carefully checks Contract Drawings and Specifications applicable to manufacturer’s equipment before roughing.

2. Reports to Architect, before or when Shop Drawings are submitted, any discrepancies or conditions applied to manufacturer’s equipment that prevents proper functioning, servicing, and other aspects of equipment operation.

3. Provides manufacturer's printed installation instructions for each piece of equipment.

4. Thoroughly instructs Contractor exactly how equipment should be installed, connected, lubricated, started, operated, and similar aspects to ensure all factory instructions are rigidly followed during installation of equipment.

F. Install, test, start, and operate equipment as instructed by manufacturer.

G. Submit written evidence from equipment manufacturer that manufacturer's equipment and systems have been:

1. Installed in strict accordance with manufacturer's recommendations.

2. Properly aligned and adjusted, tested, lubricated, wired, balanced, and similar operations

H. Equipment Connections

1. Provide final steam, condensate, heating water/glycol, drain, vent, refrigerant, and gas connections to all equipment as required.

2. Provide isolation valves and flanges or unions on the supply and return piping connections to all equipment arranged as required for reasonable service isolation and access.

3. Provide equipment condensate, and drain connections extended to floor or roof drains or other approved points of discharge. Provide integral condensate pumps and appropriate piping for units where gravity condensate drain is not practical or possible.

4. Connect equipment complete and ready-to-use, including all valves, piping, piping accessories, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, and similar components required.

I. Precautions Against Freezing: In addition to applicable requirements in Division 01 and individual technical sections, take all necessary precautions with equipment and systems to prevent damage to building, piping, equipment, and other components due to freezing and water leakage until final acceptance. Before freezing weather occurs, make certain all:

1. Safety features are properly functioning.
2. Freeze protection is tested and sensing elements are properly located.
3. Openings around outside grilles, louvers, and similar items are properly sealed; notify Architect in writing if openings are not adequately sealed.
4. Outside air dampers are tight fitting and operational, and damper motors are properly winterized.
5. Air systems are properly balanced.
6. Proper insulation is installed where required.

J. Concealment: Conceal all Work not specifically shown on the Drawings as exposed. Note piping risers may be shown outside of walls due to scale of drawing symbols – the general intent is for these pipes to be concealed within the general construction if possible or if not possible, to be within riser chases. If for any reason concealment is impossible, notify the Architect and obtain written approval before starting that part of the Work.

K. Exposed Items: Install exposed items as shown on Drawings or as approved by Architect. Obtain Architect's approval for final arrangement and appearance before installing items in areas without ceilings.

L. Damaged Components and Replacement: If pipe, duct, insulation, or any HVAC component or equipment is damaged in appearance or is otherwise unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.4 ERECTION OF SUPPORTS AND ANCHORAGES

A. Provide a complete system of support and anchorage for all Contract work.

B. Refer to Section 23 05 29 - Hangers and Supports for HVAC Components, Section 23 05 43 – Mechanical Vibration and Movement Control, and Division 05 and Division 06 complete for detailed additional requirements.

3.5 MECHANICAL PENETRATIONS, WATERPROOFING, AND SEALING

A. Openings Through Roofs: Curbs are required for rooftop air handling equipment, ventilators, fans, piping penetrations, etc. Roofing, flashing, and general waterproofing are the responsibility of the Contractor unless specifically indicated otherwise elsewhere in the Contract Documents. Refer to Architectural Drawings for related work by others.

1. Use factory pre-fabricated units as specified and noted on Drawings.

2. Caulk and waterproof neatly with additional material as required.

3. Employ the services of an approved roofing sub-contractor for all patching and/or new work indicated as part of the Heating Work.

4. Any roofing work performed under this Contract shall be performed in such a way as to not void any existing roofing warrantee. Additionally, whether there is a roofing warrantee currently in force or not for roof in area of new penetrations, all new penetration work shall be warranted leak free for a period not less than one year from final acceptance of project.

5. Provide structural support for roof deck around all roof curbs and roof deck penetrations larger than 12 inch x 12 inch, unless specifically indicated otherwise elsewhere on the Contract Documents.

B. Opening Through Outside Walls:

1. Guarantee all penetrations to be thoroughly air and watertight. Caulk and flash duct penetrations in accordance with specifications, details on Drawings, and as required.

2. Install louvers in accordance with specifications, manufacturer’s recommendations, and details, as required to achieve guaranteed air and watertight penetrations. Direct drainage to drip away from building surface.

3. Use special waterproof construction as directed.

4. Provide mechanical sleeve seals for piping penetrations.

5. Provide structural support for wall above all penetrations wider than 12 inches, unless otherwise indicated elsewhere on the Contract Documents.

C. Openings Through Floors and Inside Walls: Provide through penetration systems for all mechanical work floor and wall penetrations which do not compromise the integrity of the floor or wall with regards to fire rating, smoke passage rating, acoustical noise reduction rating, or seismic rating. Insure through penetration system does not transmit mechanical vibrations to building walls or floors. Seal all floor penetrations to effectively block the passage of smoke and fumes.

1. Provide structural support for floor deck around all penetrations larger than 12 inches in any dimension, unless specifically indicated otherwise elsewhere on the contract documents.

3.6 FIRESTOPPING

A. Provide Through-Penetration Firestopping Systems and Devices listed in UL Fire Resistance Directory under categories XHCR and XHEZ and conforming to construction type, penetrant type, annular space requirements and fire rating indicated or required for each application.

B. Provide systems that withstand passage of cold smoke either as inherent property of system or by use of separate product included as part of UL system or device designed to perform this function.

C. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the Contractor responsible for fireproofing. Install all hangers and supports prior to fireproofing.

2. Repair and/or replacement of any fireproofing removed or damaged as a consequence of the installation work of the Heating Work Contract shall be the responsibility of the Heating Work Contractor.

a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

b. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

c. Remove all excess applied fireproofing from surfaces adjacent to those requiring it, leaving area clean and neat.

3.7 ACCESS DOORS

A. Ductwork: Provide all access doors as required by Section 23 31 00 – Ductwork.

3.8 PAINTING

A. Painting of HVAC systems, equipment, and components is additionally specified in Division 09 Sections on Painting.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Vary initial and final coat colors slightly as required to provide positive identification between coats. Do not proceed with final coat until initial coat is properly cured per manufacturer's instructions, and has been approved as complete by Owner's Project Representative. Final coat shall completely conceal initial coat(s).

D. Paint Requirements:

1. Provide painted finish for HVAC components (exposed equipment, piping, duct, supports and insulation in particular) exposed to view in finished spaces such as gymnasiums, classrooms, offices, corridors, etc. Provide factory painted finishes as specified elsewhere or if not factory painted then field painted. Refer to Division 09 for painting specifications and additional painting requirements if required.

    a. Provide touch up painting as required to repair, or replace as directed, damaged factory finishes of HVAC components.

2. Paint all exposed metal surfaces that will be above 150 degrees F when in operation, with two coats of heat resistant paint.

3. Paint all miscellaneous fabricated ferrous supports complete.

4. Paint all ferrous piping and components located outdoors as specified in Division 09, except where insulation is to be applied over piping or component.

5. For piping that will be subject to moisture induced corrosion on the exterior of the piping, provide one full coverage coat of corrosion inhibiter equal to "Polyguard RG-2400" on the following ferrous (steel) piping and fittings before insulation is applied:

    a. All exterior ferrous piping.
    b. All ferrous piping where the fluid in the piping operates at below ambient conditions (all cooling piping)
    c. All below grade ferrous piping.

6. Do not paint

    a. Chrome plated materials, aluminum and brass valves, or brass trim on iron body valves, stainless steel materials, copper indirect waste piping, laboratory waste and vent piping.

    b. Piping above finished ceiling spaces, except un-insulated ferrous piping and supports.

c. Exposed copper pipe, brass valves, or brass trim on iron body valves, or machinery or equipment with factory-applied finish, unless otherwise specified.

7. Coating Systems: Comply with application and material requirements specified in Division 09.

8. Color Code Identification: Provide color code identification of mechanical piping in Boiler Rooms, Mechanical Rooms and Fan Rooms by painting the following services as listed below.

	Item	Color
a.	Heating hot water supply	Dark Red
b.	Heating water return	Light Red
c.	Steam supply	Orange
d.	Condensate (steam)	Rust brown
e.	Refrigerant	Dark Green
f.	Hangers, supports, base rails, etc.	Black
g.	Condensate (AC drain)	White (ASJ without paint OK)
h.	Chemical treatment	White (ASJ without paint OK)

3.9 PROTECTION

A. Maintain systems during construction, temporary use, and until acceptance by Owner.

1. Properly lubricate all HVAC systems bearings during use.
2. Maintain limit controls, overload devices, and safety controls in operating condition during use

3.10 ALTERATIONS

A. Provide protection of existing facilities, demolition and removals, replacement and restoration, including patch-to-match requirements, and hazardous materials procedures to install Heating Work in conformance with Division 01 requirements.

B. Provide cutting and patching required to install Heating Work in accordance with the requirements of Division 01 covering cutting and patching.

3.11 ADJUSTING AND CLEANING

A. Adjust all work as required to insure systems perform as designed and as intended, including but not limited to the following:

1. Adjust all registers and diffusers to insure even air distribution free of objectionable drafts. Include all new and all existing to remain registers and diffusers on systems where HVAC modifications are made.

2. Adjust all hangers and supports to insure proper piping slope, alignment of flexible connections, even loadings, proper venting and draining, proper control over thermal expansion, etc.

3. Adjust all mechanical equipment insuring it runs properly as intended, providing the performance specified and required, and as required to maintain all warrantees.

B. Clean work furnished or provided as part of Heating Work, including but not limited to equipment, control panels and devices.

1. Refer to and comply with Section 01 50 00 - Temporary Facilities and Controls for additional requirements for cleaning during construction and Section 01 77 00 – Closeout Procedures for additional requirements for final cleaning.

2. Remove debris, leftover piping, tubing, metal, insulation, cartons, papers, etc., resulting from Heating Work.

3. Remove all rust, dirt, oil, etc. from Heating Work to be painted and maintain in condition ready for painting.

4. Clean inside and outside of all equipment and distribution systems provided including (but not limited to) following:

a. All enclosures.

b. Remove all rust, oils, and similar contamination from all equipment, piping and supports to be painted, and leave components ready for painting.

c. Remove debris, leftover piping, wiring, tubing, metal, insulation, cartons, papers, and similar items left in building or on Site. Clean building as often as necessary and when directed by Architect.

C. Final Cleaning: In addition to requirements specified in Section 01 77 00 – Closeout Procedures and other sections in Division 23, provide following measures.

1. Where heating units have been used to provide temporary heat, clean all permanent filters, replace all disposable filters, and clean all ducts, blowers, and coils.
2. Clean all piping strainers and replace all "startup" screens with permanent screens.
3. Provide written notification to Architect upon completion of all final cleaning procedures and request inspection of final cleaning.

3.12 DEMONSTRATION OF COMPLETED SYSTEMS:

A. Prior to Final Completion, thoroughly demonstrate and instruct Owner’s designated representatives in care and operation of all heating and ventilating systems and equipment provided in Heating Work. Provide necessary skilled labor to operate all systems for not less than 5 days and provide required instruction.

1. In addition to Contractor’s instruction, arrange for technically qualified factory representatives to train Owner's designated representatives in care, maintenance, and operation of following manufacturer’s equipment and systems.

a. Temperature controls.
b. Central station air handling equipment and units.

c. Energy recovery equipment.
d. Air conditioning units and equipment.
e. Variable speed drives.

2. Coordinate and schedule time and place of all training through Architect at Owner's convenience.

3. Submit letters verifying satisfactory completion of all instruction including date of instruction, names of persons in attendance and countersigned by authorized representative of Owner.

4. Until final acceptance, Contractor retains full responsibility for systems operations and maintenance, even though operated by Owner's personnel during instruction, unless otherwise agreed to in writing.

5. During instruction, provide list, sealed in clear plastic, outlining operating, maintenance, and starting precautions and procedures to be followed by Owner for operating systems and equipment.

B. Lubrication Chart: Provide minimum 8-1/2 inch x 11 inch lubrication chart for all Work in Heating Work Contract, typed in capital letters, mounted under clear laminated plastic, and secured to wall where directed by Architect.

1. List all motors and equipment including following information:

a. Name and location of equipment.
b. Type of lubrication recommended by manufacturer.
c. Lubrication period recommended by manufacturer.

2. Lubricate all motors immediately after installation and perform lubrication maintenance until final acceptance by Owner.

C. Air Filter Chart: Provide an air filter chart for all equipment installed in contract.

1. Chart shall be 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall where directed.

2. List all equipment that includes filters in Contract. Obtain necessary information containing the following:

a. Name and location of equipment
b. Type of filters recommended by the manufacturer.
c. Size of filters for each piece of equipment.
d. Recommended replacement schedule from unit manufacturer.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. General requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

2. Starters and drive train accessories for electric motors.

3. Electrical auxiliary components required for HVAC systems that are not specifically identified in “E” series Drawings or Division 26.

4. Electrical wiring required for HVAC systems that is not specifically identified in “E” series Drawings or Division 26.

1.3 SUBMITTALS

A. General: Submit all action submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of product indicated, demonstrating compliance with all specified performance and construction characteristics.

C. Closeout Submittals:

1. Installation, Operation, and Maintenance Data: For motors, drives, and electrical power components - include in operation and maintenance manuals.

a. Wiring Diagrams: Employ competent technical aid to prepare composite wiring diagrams for field wiring of power, signal, and control wiring for all equipment and systems installed as part of the HVAC Work. Deliver diagrams to proper parties in time for roughing of conduit and equipment connections. Clearly indicate all items to be mounted or wired as part of DIVISION 26. Include as built wiring diagrams in O&M manual.

1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Manufacturers: Provide products by one of following manufacturers or equal, except where unusual configurations involving frame, hermetic seals, shaft, bearing, or starting characteristics are peculiar to particular item of equipment as specified by Architect:

1. National Resource Management (NRM).
2. Baldor.
3. General Electric.
4. U. S. Motors.

B. Provide all motors required for the work of Division 23 specifications. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or individual technical specification sections.

1. Provide motors wound specifically for voltages as scheduled and available, with 1.15-service factor at rated voltage and frequency complying with all applicable NEMA standards.

C. Provide all motors suitable for operation at the frequency, voltage, and phasing of the building power.

D. Provide motors 1/2 HP and larger and motors indicated as driven by variable speed drives, designed for operation on 3-phase power, voltage as shown on electrical plans, +/- 10 percent, unless specifically indicated otherwise on drawings.

E. Provide constant speed motors 1/3 HP and smaller designed for operation on single phase, 120 volts +/- 10 percent.

F. Comply with NEMA MG 1 unless otherwise indicated.

G. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS AND APPLICATIONS

A. Provide each motor suitable for continuous duty operation at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level, and suitable for speed, enclosure, rating, type and horsepower not less than as scheduled or specified in Contract Documents. Provide motor enclosure and maximum allowable temperature rise in degrees Centigrade over 40 deg. C ambient as follows, unless otherwise specified:

1. General Purpose: Drip-proof 40 deg. C or encapsulated design 60 deg. C.
2. Roof-top unit, damp, high humidity, or condensing applications: Totally enclosed fan-cooled 50 deg. C or drip-proof encapsulated design 60 deg. C.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Each equipment manufacturer is responsible for ensuring motors supplied with manufacturer's equipment are fully compatible with the application and capable of starting and running driven equipment without undue noise, heating, or distress.

2.3 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.
5. Electronically Commutated Motor (ECM)

B. Motors 1/20 HP and Smaller: Shaded-pole type.

C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

D. Variable Speed Motors: Electronically commutated motor (ECM) shall be of permanent magnet, brushless DC premium efficiency design with variable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball bearings, and extra quiet operation are all included.

E. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.4 POLYPHASE MOTORS

A. Single Speed General Application Motors:

1. NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium efficiency, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Random-wound, squirrel cage rotor.
5. Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
6. Insulation: Class F.
7. Temperature Rise: One class below insulation rating.
8. Motors 15 HP and Larger: NEMA starting Code F or Code G.
9. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
10. Enclosure Material: Manufacturer's standard rolled steel or cast iron enclosures corresponding to NEMA rating and application requirements.

B. Multi-Speed General Application Motors:

1. Similar to single speed motor requirements above, with separate winding for each speed.

2. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Motors Used with Variable Frequency Controllers:

1. Motors shall meet all other requirements of this document, the driven equipment manufacturer, and the Variable Frequency Controller manufacturer, and be rated for this service with the drive and voltage intended. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2. All three phase motors for use with variable frequency controllers shall be special application, inverter duty premium efficiency motors of cast iron construction.

3. Ratings shall be in accordance with NEMA MG-1, Part 31 requirements for the specific application.

4. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

5. Class B temperature rise; Class F insulation.

6. Thermal protection via one Class F thermostat per phase, NEMA MG 1 compliant with requirements for thermally protected motors.

D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 MOTOR ACCESSORIES

A. For all new motor installations, whether in new equipment or installed as replacement motors, provide accessories listed below as required for a complete new drive system.

B. Direct connected motors: provide with flexible couplings if required by application and OSHA approved belt guards surrounding rotating machinery.

2.6 STARTERS

A. Manufacturers: Provide all starting equipment and control devices manufactured by same manufacturer and furnished through single responsible supplier unless otherwise specified in Contract Documents. Factory-wired or assembled packaged equipment may be provided with starting equipment of any acceptable manufacturer. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cutler-Hammer
2. General Electric
3. Square D

B. Provide starters, contactors, and controllers complying with applicable NEMA standards, minimum size 0, and enclosed in enclosures of type appropriate for environment where installed including general purpose, explosion proof, weather resistant, or weather-tight construction as required.

C. Ensure all parts subject to wear, arcing, and similar use are easily removable.

1. Provide necessary auxiliary contacts for each starter subject to electrical interlock or automatic control.

2. Equip magnetic starters for motors operating 208 volts and over, line-to-line, equipped with self-contained light loads imposed thereon with a control transformer having a 120-volt grounded secondary winding, and having 120-volt starter operating coils.

D. Provide combination-type magnetic starters with fused disconnect switches. Fuse with class R fuses. Protect all starters with manual reset, solid state overload relay equal to (Square “D” motor logic) in one leg of single phase line to neutral circuits, in two legs of single phase line-to-line circuits, and in three legs of 3-phase circuits.

E. Provide 6-volt, red pilot light, integral transformer and long life bulb for all starters and contactors.

F. Manual Starters: Toggle operated, single pole for line to neutral circuits, two pole for line-to-line circuits, with thermal overload devices and neon pilot light; flush mounted unless shown otherwise, ganged with selector switch for multispeed applications. Provide manual starters similar to one of the following:

1. General Electric CR-101
2. Cutler-Hammer 9101
3. Square D Class 2510

G. Combination Magnetic Starters: Single speed, across the line, HAND-OFF-AUTO selector switch in cover. Provide combination magnetic starters similar to one of the following:

1. Cutler-Hammer 9589
2. General Electric CR-107
3. Square D Class 8538

H. Magnetic Contactors: With control coil in series with temperature controls as required.

2.7 COMPONENTS

A. Electrical Wiring: Provide all materials conforming to NEMA Standards and UL approved for intended service. Refer to appropriate sections in Division 26.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which materials and methods are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in acceptable manner.

1. Installation indicates conditions are acceptable to Contractor as required to ensure requirements for applicable warranty or guarantee can be satisfied.

2. Motors and Starters: Confirm electrical characteristics for all equipment.

3. Electrical Wiring: Check all electrical wiring associated with equipment for compliance with specifications and correctness of connections. Correct wiring in event equipment or devices fail to function in specified manner, whether due to incorrect connections or improper information and wiring diagrams.

B. Inspect and perform tests on project electrical wiring, including infrared scans (thermography), resistance testing, or other industry standard testing as required to demonstrate acceptable wiring. Owner reserves the right to provide their own additional similar testing:

1. Cost of Contractor's testing included in bid price. Cost of Owner's testing of acceptable installations provided at Owner's expense.
2. Repair installations not passing Contractor's or Owner's quality inspection testing using approved method or replace at no additional cost.
3. Cost of initial testing of wiring not conforming to specified requirements and any retesting of repairs or replacement work deducted from Contract Sum.

3.2 INSTALLATION

A. Motors and Starters

1. Correct, at no additional cost, any misapplied motor or starter combination and improper thermal overload devices for motor starters provided as part of HVAC systems or components, along with damage to other equipment or construction.

2. Motors: Provide motors furnished by equipment manufacturer, specifically manufactured or selected for equipment served; mounted, and installed to provide complete installation that is substantially noiseless in performance under intended use. Replace motors unsatisfactory to Architect with new motor.

3. Starters and Accessories

   a. Provide starters and disconnects for all HVAC equipment. Refer to Equipment Schedules.
   b. Provide auxiliary contacts required for temperature controls, interlock with other equipment, alarms, and similar components and applications.

B. Miscellaneous Electrical Wiring included in HVAC systems installations:

1. Provide all control wiring and power wiring for all equipment and associated control devices (including automatic control system) required for HVAC systems and components.

2. Comply with all applicable NEC requirements. Install all electric wiring in accordance with all local and state codes and regulations having jurisdiction.

3. Wiring for Controls: Provide wiring specified in Section 23 09 00 – Instrumentation and Control for HVAC, for all control devices required for temperature control system and other miscellaneous controls not included in "Electrical Equipment and Control Schedule".

4. Allow sufficient headroom under equipment as directed for each location (unit heater, etc.). Verify space available for each equipment item. Refer to Architect for any correction, discrepancy or suggested change in size of location.

5. Secure all equipment and fixture mountings, wiring devices, and accessories (clips, supports, etc.) to structure with screws, bolts, or similar items; nailing not acceptable.

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAUGES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Gauge attachments.
4. Test plugs.

1.3 SUBMITTALS

A. Procedural Requirements: Comply with requirements of Section 01 33 00 - Submittals and as modified below.

1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit "**As-Specified Verification Form**" (attached to Section 01 33 00 - Submittals) in lieu of "Product Data" identified below in this Article.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.

B. Action Submittals:

1. Submit all action submittals required by this Section concurrently.
2. Product Data: For each type of product indicated, demonstrating compliance with specifications. Include schedules of locations and ranges proposed.

C. Closeout Submittals:

1. Approved submittal.

a. If "**As-Specified Verification Form**" submittal is approved, also include product data for all valves used.

2. Include all information required in Section 01 78 23 – Operation and Maintenance Data for all meters and gauges used. Include wiring diagrams for meter power, signal, and control wiring.

1.4 EXTRA MATERIALS

A. Furnish extra materials that match products specified and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete test plug kit with training as described below. Include receipt signed by Owner's representative in closeout documentation.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Trerice, H. O. Co.
b. Weiss Instruments, Inc.
c. WIKA Instrument Corporation - USA.
d. Winters Instruments - U.S.

2. Standard: ASME B40.200.

3. Case: Cast aluminum; exterior grade powder coated finish, 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and non-mercury blue or red organic liquid.

6. Tube Background: Non-reflective with permanently etched scale markings graduated in deg F.

7. Window: plastic.

8. Stem: Bare aluminum of length to suit installation.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing or Steel Piping: solid machined de-zincification resistant brass or stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: ASME B1.20.1 pipe threads, size as required for sensors.
6. Internal Threads: ASME B1.1 screw threads, size as required for sensors.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin unless otherwise required by sensor manufacturer.

2.3 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: De-zincification resistant brass, bronze, or stainless-steel needle type, slow opening, bubble tight shutoff, with ASME B1.20.1 pipe threads.

2.4 TEST PLUGS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3D instruments Inc.
2. Flow Design, Inc.
3. Peterson Products Co
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.

B. Test Plugs:

1. Description: Test-station fitting made for insertion into piping tee fitting.

2. Brass or stainless steel body, NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread with Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber core inserts and gasketed and threaded cap with retainer. Include extended stem on units to be installed in insulated piping.

3. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

C. Test-Plug Kits

1. Furnish one test-plug test kit containing two thermometers, one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

2. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

3. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

4. Pressure Gauge: One pressure gauge as specified above with insertion type adapter probe. Dial range shall be 0 to 100 psig.

5. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install meters and gauges adjacent to machines and equipment in easily readable position but protected locations to allow and facilitate service and maintenance of meters, gauges, machines, and equipment.

B. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees. Provide thermometer stems of length to match thermowell insertion length.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes. For pipe sizes 1 inch and smaller, increase pipe size by one size at location of thermowell to minimize obstruction.

D. Install thermowells with extension on insulated piping. Insulate fitting past piping well and neatly terminate insulation at thermometer body minimizing heat loss while allowing for adjustment.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

H. Install test plugs in piping tees in location that allows for ease of insertion of standard test kit probes.

3.3 LOCATIONS

A. Install thermometers in the following locations, and as additionally shown on drawings:
   1. Inlet and outlet of each air handler heating coil.

B. Test Plugs and Test Plug Kits:

   1. Provide Pressure / Temperature Test Plugs at the supply and return connections to each new air / water heat transfer coil, adjacent to each thermometer and pressure gauge, and as noted on the drawings.

   2. Furnish one Test Plug Kit loose to Owner, and provide for training of Owner's personnel in its use.

3.4 ADJUSTING

A. After installation, calibrate meters and gauges according to manufacturer's written instructions. Coordinate calibration with Testing and Balancing Agency (TAB) and include results in TAB report.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.5 THERMOMETER TYPE SCHEDULE

A. Thermometers in exterior locations or interior locations shall be the following:

   1. Industrial-style, liquid-in-glass type.

3.6 THERMOMETER SCALE-RANGE SCHEDULE

A. Provide thermometers of approximately the scale range indicated:

   1. Scale Range for Heating, Hot-Water / Glycol Piping: 30 to 250 deg F .
   2. Scale Range for Steam and Steam-Condensate Piping: 30 to 250 deg F .
   3. Scale Range for Outside Air: Minus 20 to plus120 deg F.
   4. Scale Range for return and Supply Air: 30 to plus120 deg F.

END OF SECTION 23 05 19

SECTION 23 05 23 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Brass and bronze ball valves.
2. Iron, single-flange butterfly valves.
3. Iron, grooved-end butterfly valves.
4. Manual Balancing valves
5. Bronze globe valves.
6. Air vent valves

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 SUBMITTALS

A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit "**As-Specified Verification Form**" (attached to SECTION 01 33 00 - Submittals) in lieu of "Product Data" identified below in this Article.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.

B. Action Submittals:

1. Product Data: Submit concurrently for each type of valve proposed, demonstrating compliance with requirements.

C. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittal.

a. If "**As-Specified Verification Form**" submittal is approved, also include product data for all valves used.

2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.

3. Receipt: Differential Pressure Flow Test Kit(s).

4. Valve Schedule: Refer to Section 23 05 53 – Identification for HVAC Components, for details.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products specified and that are packaged with protective covering for storage and identified with labels describing contents. Include receipt signed by Owner's representative in closeout documentation.

1. Provide one complete Differential Pressure Flow Test Kit for each different type of balancing valve included in the project, with training as described below.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 6 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 5 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE AND BRASS BALL VALVES

A. Two-Piece Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Solder or Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full or Regular per application schedule.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 216 carbon steel, ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM/Teflon, reinforced, resilient, for water temperatures up to 250 deg. F at 150 PSI.
f. Stem: 316 or 416 stainless steel shaft mounted within corrosion resistant bearings.
g. Disc: Aluminum bronze, bronze, or nickel coated iron.

2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil International, Inc; “Gruvlock”.
b. NIBCO INC.
c. Victaulic Company.

2. Description:

a. Standard: MSS SP-67, Type I.
b. NPS 8 and Smaller CWP Rating: 300 psig.
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: EPDM/Teflon coated ductile iron.
f. Seat: EPDM/Teflon, reinforced, resilient, for water temperatures up to 250 deg. F at 150 PSI.

2.5 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.6 MANUAL BALANCING VALVES

A. Provide combination globe-type calibrated flow measuring balance, shutoff, and throttling valve with provision for attaching portable differential pressure meter with each meter connection having positive shutoff access valves equipped with removable insulating cover providing minimum R of 4.5. Rated for 250 PSI at 250 deg. F and provided with calibrated nameplate, 1/4-inch drain/purge port, and drip-tight shut off. Similar to “CBV” by Armstrong, “3D” by B & G, or similar products by Tour & Anderson.

B. Threaded, grooved, or flanged ends as required to fit system piping with bronze, A-metal, or dezincification resistant brass body for pipe sizes 1/2-inch to 2-inches inclusive or cast or ductile iron body with bronze internal parts and Teflon or EPT seals rated for the service fluid and temperature for pipe size 2-1/2-inches and larger.

1. Valves designed to allow for presetting of balance points for proportional system balance prior to system start up.

C. Valve Size: As required to meet the Cv indicated on the Drawings, or if not indicated on Drawings, provide the larger of pipeline size or size required to provide maximum 5 ft. water gauge pressure drop at design flow.

D. Read-Out Ports: Include internal EPT inserts and check valves.

E. Adjustment Knob: Includes minimum of four full turns (1440 degrees) from bubble tight shutoff to full open position and includes pre-set feature indicating degree of valve opening including memory position stop and indicator.

2.7 AIR VENTS

A. Manual Air Vents:

1. For All Pipe Sizes In Accessible Locations Only: Bronze body, quarter turn ball valve with minimum 1/4-inch discharge and inlet connections. Provide collection chamber at inlet and 1/4-inch tube with return bend on outlet, piped to point of collection.

2. For Terminal Units In Accessible Locations: Bronze or brass body and non-ferrous internal parts, 150 PSIG working pressure, 225 deg. F operating temperature. 1/8-inch MNPT inlet connection. Coin or key operated, supply three keys minimum to owner. Similar to “Model 4V” by Bell & Gossett.

B. Automatic Air Vents:

1. High Capacity Type: Cast iron body with internal working parts of stainless steel, brass, bronze, and EPDM and float-operated sealing valve designed to purge free air from the system and provide positive shut off at pressures to 125 PSIG and temperatures to 250 deg. F. Vent prevents air from entering the system if system pressure drops below atmospheric. Vent readily serviceable by disassembly to access the internal working parts. Similar to “Model “107A” by Bell & Gossett or “720” by Amtrol.

2. Standard Capacity Type: Cast bronze body with internal working parts of stainless steel, brass, bronze and EPDM and float operated sealing valve designed to purge free air from the system and provide positive shut off at pressures to 150 PSIG and temperatures to 230 deg. F. Vent prevents air from entering the system if system pressure drops below atmospheric. Vent readily serviceable by disassembly to access the internal working parts. Similar to “No. 700-C” or “701-C” by Amtrol.

2.8 DIFFERENTIAL PRESSURE FLOW TEST KIT

A. For each type of balancing valve, include flow test kit with probes, hoses, flow charts, carrying case, and accessories as required for complete flow readings, and turn over to Owner. Obtain receipt.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage. Verify dielectric bolt kits are provided for flanged connections between dis-similar materials.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Install isolation valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Install isolation valves at each new branch connection serving three or more pieces of terminal equipment, and as additionally shown on drawings.

C. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

D. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 inch and Smaller: Threaded or solder joint ends.
2. For Copper Tubing, NPS 2-1/2 inch and larger: Flanged ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 inch and Larger: Flanged or grooved ends.

3.3 GENERAL DUTY VALVE SCHEDULE

A. Unless otherwise specifically indicated elsewhere, use the following:

B. Hydronic Flow Shutoff Service:

1. 2 inch and smaller: Full Port Ball Valves
2. 2-1/2” and larger: Butterfly Valves.

C. Pressure Gage Shutoff Service: Standard or Full Port Ball valves.

D. Flow Adjustment and Balancing:

1. Provide line size manual adjustment balancing valves for service on branch main lines serving multiple terminal loads, where shown on drawings.
2. Provide line size manual adjustment balancing valves for all individual terminal loads.
3. Select final flow based on approved submittals, not on flow indicated on contract documents.
4. Train Owner's representative on balancing / flow control valve adjustment and use of differential pressure flow test kit.

E. Hydronic System Drain Service: Provide drain valves at all system local or global low points as required for complete system drainage.

1. 2-1/2 inch and larger service: Provide ¾ inch full port ball valves with ¾ inch hose thread end and chained cap.
2. 2 inch and smaller service: Provide ¾ inch full port ball or globe valves, with ¾ inch hose thread end and chained cap.

F. Hydronic System Air Venting:

1. Manual vents: provide standard or full port ball valve, minimum 1/4" NPT; ½" NPT on 4" and larger piping.

2. Provide Standard Capacity Type Automatic Air Vent at accessible points in piping system where air may collect, including all local high points and at the end of each horizontal run before a drop in elevation.

    a. If any such point will be inaccessible after construction is complete, provide only Manual Air Vent in lieu of automatic, installed as described below.

3. Equipment Air Vents:

    a. Equipment Above Mains: Connect run outs or risers to upper quadrant or top of mains. Install vent assembly at branch high point, concealed within enclosure if possible, consisting of 1 in. diameter by 6 in. long air collection chamber with 1/4 in. soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units, radiators, fan convectors and units with return grilles: Provide coin air vent valve, operated from discharge grille or access door. Positioning of valve shall not interfere with removal of enclosure.

    b. Equipment Below Mains: Connect piping run outs or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit. Use tees instead of ells at low point of run outs.

3.4 VALVE INSTALLATION

A. When installing solder-joint end valves, protect valve body from soldering heat using water soaked rags or other heat sink method as required to avoid valve damage. Leaking stems or seats on solder-joint end valves shall be subject to immediate replacement with new valve.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem and handle movement.

E. Install all Automatic Air Vents above manual vent assembly described below, with discharge piped to point of collection - for glycol venting, pipe discharge to glycol feed station as shown, or if not shown to minimum 1 quart clear plastic container, secured and removable for service.

F. Install all Manual Air Vents with air collection chamber above flow piping (minimum line size diameter x 6 inches long), and minimum ¼" tube extended to accessible location, terminating with ball valve located so liquid discharged during venting may easily be collected in minimum 1 quart container.

1. Coin vents may be connected directly to equipment served.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
B. Division 06 section “Roofing Rough Carpentry” for roof mounted support blocking.

1.2 SUMMARY

A. Section Includes

1. Hangers and supports for (but not limited to) following components:

   a. Piping hangers and supports
   b. Duct hangers and supports
   c. Equipment hangers and supports

2. Roof mounted supports and equipment penetrations including (but not limited to):

   a. Roof curbs.
   b. Pipe curb assembly
   c. Equipment support rails
   d. Pipe and duct supports

3. Miscellaneous components and accessories including (but not limited to):

   a. Anchors
   b. Guides
   c. Fasteners
   d. Custom supports
   e. Insulation protection systems

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. This section does not detail mechanical vibration or movement control requirements. Refer to Section 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL for additional hanger and support requirements.

B. Provide corrosion resistant construction as described below for hangers, hanger rods, supports, fittings, hardware, etc, unless otherwise noted or approved. Note that not all products described below are available in corrosion resistance as required for all applications listed – select appropriate corrosion resistant products as required. Multiple conditions may apply, in which case the more corrosion resistant construction is required:

1. General purpose indoor: ASTM B-633 Fe/Zn 25 minimum zinc plated fasteners, ASTM B-653 G90 minimum sheet steel, factory baked enamel paint, or anodized.

2. In contact with copper: Copper plated for size identification and felt lined or plastic coated.

3. In contact with aluminum: Same aluminum alloy as equipment or 300 series stainless steel. 300 series stainless steel fasteners.

4. Outdoors, in crawl spaces, manholes, pits, and below grade: 300 series stainless steel or post-fabrication (after forming, welding, drilling, etc.) ASTM A-153 hot dipped galvanized steel, minimum coating thickness 3 mils.

5. Miscellaneous fabricated custom supports, anchor bases, etc..: painted in accordance with Section 23 05 00 – COMMON WORK RESULTS FOR HVAC.

6. Other special conditions: where noted on drawings, provide materials of special temperature, corrosion resistance, or other properties, as required for durable and safe performance.

C. Allowable Working Loads:

1. Use only manufacturer's load rated hangers, supports, and fasteners designed and rated for the intended service.

2. Do not load connectors, hangers, or supports to more than the manufacturers′ recommended working load or the following:

a. Use a safety factor of 5:1 minimum with respect to manufacturers′ published ultimate shear strength.
b. Use a safety factor of 10:1 minimum with respect to manufacturers′ published ultimate tension or pull-out strength.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product literature, technical specifications, and other data required to demonstrate compliance with specified requirements for following components:

1. Hangers and supports
2. Roof mounted supports
3. Miscellaneous components

B. Roofing Work:

1. Submit qualifications of proposed roofing and structural subcontractor(s)

2. Submit copy of any existing roofing warranty and certification by existing warranty holder that proposed roofing subcontractor is certified to provide compliant roofing warrantee work and that this project's roofing work will not (before construction) and has not (after construction) voided any warranty.

3. Submit copy of new warranty for roofing performed on existing out-of-warranty roofing.

C. Shop Drawings: Submit intended custom support construction for approval.

D. All supports, etc., shall meet the approval of the Architects / Engineers. Submit shop drawings showing fabrication and installation details including calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Pipe stands.
3. Equipment supports.
4. Include detailed layout and loading drawings for all above roof piping and equipment.

1.6 QUALITY ASSURANCE

A. Comply with applicable requirements of following standards for all hangers and supports:

1. MSS-SP-58 Pipe Hangers and Supports – Materials, Design, and Manufacture.
2. MSS-SP-69 Pipe Hangers and Supports – Selection and Application.
3. ANSI / ASME Code for Pressure Piping B 31.1
4. ASTM standards for corrosion resistant Zinc coatings.
5. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
6. UL 203 Standard for Pipe Hanger Equipment and Fire Protection Service
7. Metal Framing Association MFMA-2
8. SMACNA – Sheet Metal and Air Conditioning Contractor's National Association, Inc.

PART 2 - PRODUCTS

2.1 GENERAL

A. For convenience, details and specifications have been based on product types as defined in MSS SP-58 and 69 where applicable, and, where not applicable, catalog numbers shown have been based on products by the listed manufacturers.

2.2 PIPING ATTACHMENTS

A. Individually Suspended Horizontal Rigid Piping or Tube Attachments:

1. Band type:

    a. 1-1/4 inch diameter pipe size and less only.
    b. Formed steel loop overlapped at top with rod sized hole or insert nut. With or without side insert closure.
    c. MSS SP-58 type 5, 6, or 10.

2. Clevis type:

    a. Any size pipe or tubing.
    b. Formed steel bands top and bottom connected by sheer bolt.
    c. MSS SP-58 type 1.

3. Roller type:

    a. Any size pipe or tubing.

    b. Radiused or angled roller and steel axle; yoke for single hanger rod or end sockets for double rod applications. Designed to accommodate longitudinal movement through roller action.

    c. MSS SP-58 type 41 and 43.

4. Provide products by one of the following manufacturers:

    a. B-Line Systems, Inc., Highland Illinois, or equal
    b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
    c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

B. Supported from below Horizontal Rigid Piping or Tube Attachments:

1. Split Ring type:

    a. 1-1/4 inch diameter pipe size and less only.

    b. Cast malleable iron split ring with steel pivot and bolt, cast boss on one side threaded for standard rod or pipe attachment. Designed to accommodate minimal longitudinal movement only.

    c. MSS SP-58 type 12.

2. Stanchion Saddle type:

    a. Any size pipe and tubing.

    b. Radiused pipe saddle support with U-bolt upper restraint. Threaded adjuster rod or pipe integral / welded to saddle for vertical adjustment. Designed to accommodate minimal longitudinal movement only.

    c. MSS SP-58 type 37.

3. Roller type:

   a. Any size pipe or tubing.

   b. Radiused or angled roller and steel axle with end sockets for double rod applications. Provide with U-bolt upper restraint. Designed to accommodate longitudinal movement through roller action.

   c. Roller MSS SP-58 type 41 and U-bolt MSS SP-58 type 24.

4. Provide products by one of the following manufacturers:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
   c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

C. Group Supported or Suspended (Trapeze) Horizontal Rigid Piping or Tube Attachments (Common Support Beam):

1. Support frame or trapeze beam of load rated brackets or channel strut product.

2. U-Bolt type:

   a. Any size pipe or tubing.

   b. Insulation support system rests directly on beam or shim, with U-bolt or split strut clamp upper restraint. Designed to accommodate minimal longitudinal movement only.

   c. U-bolt MSS SP-58 type 24, Strut clamp similar to B-Line “B-2000” series.

3. Radius Roller type:

   a. Any size pipe or tubing.

   b. Radiused roller and steel axle with end sockets for double rod applications. Provide with U-bolt upper restraint. Designed to accommodate longitudinal movement through roller action.

   c. Roller MSS SP-58 type 41 and U-bolt MSS SP-58 type 24.

4. Angled Roller type:

   a. 6 inch diameter pipe size and less only.

   b. Angled rollers with steel axles and formed steel angle clips designed for channel strut mounting. Provide with U-bolt upper restraint. Designed to accommodate longitudinal movement through roller action.

   c. Roller similar to B-Line “B218” or “B219” and Strut clamp similar to B-Line “B-2000”.

5. Provide products by one of the following manufacturers:

    a. B-Line Systems, Inc., Highland Illinois, or equal
    b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
    c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

D. Individual Vertical Rigid Piping and Tube Attachments:

1. Split Ring type:

    a. 1-1/4 inch diameter pipe size and less only.

    b. Cast malleable iron split ring with steel pivot and bolt, cast boss on one side threaded for standard rod or pipe attachment. Designed to accommodate minimal longitudinal movement only.

    c. MSS SP-58 type 12.

2. Riser clamp type:

    a. 1-1/2 inch diameter pipe size and larger.

    b. Twin formed steel bands with formed radius to fit pipe and extension wings drilled for clamping bolts, space between extension wings designed to accept various connections to building structure.

    c. MSS SP-58 type 8.

3. Provide products by one of the following manufacturers:

    a. B-Line Systems, Inc., Highland Illinois, or equal
    b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
    c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

E. Flexible Pipe, Tube, or Hose:

1. Lengths three feet and under to be supported by adjacent piping system.

2. Similar to attachments for rigid piping systems described above, with “V” notch bottom in lieu of radius, and associated continuous rigid trough angle of same material spanning between attachments.

F. Piping Insulation Protection Systems:

1. Pipe Insulation Shields:

    a. One Piece:

        1) Formed steel, minimum 18 gauge thickness, longer of 2 times diameter or 12-inch long minimum, and 180 degree circumference, sized for insulation thickness.

2) MSS SP-58/69 type 40.

b. Two Piece Sliding:

1) Manufactured two piece sliding shield system designed to accommodate thermal movement.

2) MSS SP-58/69 type 40 inner shield similar to one piece shield above adhered to pipe insulation, with second outer shield of formed steel, minimum 18 gauge thickness, one times diameter length 6-inch long minimum, and 180 degree circumference, sized to fit outside inner shield, with formed ribs to keep shield centered on support clevis or trapeze.

3) Inner and outer shields separated by layer of PTFE (Teflon), minimizing friction between shields and allowing minimum four inches controlled pipe movement relative to hanger without insulation damage or outer shield moving past the end of the inner shield.

2. Type “A” Insulation Protection System:

a. 1” piping and smaller only.
b. Provide one piece or two piece sliding shield as required by distance from piping anchors.

3. Type “B” Insulation Protection System:

a. 1¼” through 8” heating piping only.

b. Provide one piece or two piece sliding shield as required by distance from piping anchors.

c. Pipe Support Insulation: High density (20 pcf). molded fiberglass blocks consisting of fiberglass wool and urea-phenolic resin cured binder. Provide number and size of support blocks as required to limit deflection to 1% and avoid long-term damage to vapor barrier, and as required for pipe size and insulation thickness, in accordance with manufacturer’s written guidelines and project details. Seal cut in piping insulation vapor barrier using manufacturer’s recommended matching tape. Similar to AHAMFAB H-Block" by ICA

4. Provide products by one of the following manufacturers:

a. B-Line Systems, Inc., Highland Illinois, or equal
b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
c. ICA Inc.; Lehighton, Pennsylvania, or equal.
d. Buckaroos, Inc.

2.3 DUCT ATTACHMENTS

A. Per SMACNA Duct Manual standards for size, height, and location of ductwork, and as noted below.

1. Materials and corrosion resistance as listed above.

2. SMACNA load tables allow for no external loads on duct: provide for 200 lb external load on all duct hangers and supports. Increase hanger and support sizes from SMACNA tables accordingly:

   a. Minimum band size 20ga. x 1 inch.
   b. Duct 48" wide and larger; provide trapeze style support of metal channel framing or angle iron, suspended from threaded rods.

3. Hanger bands to extend down sides and turn under bottom 1 inch minimum for all duct sizes. Minimum (2) #10 sheet metal screws per hanger (one each on side and bottom), (2) screws minimum on sides for duct over 12 inches tall, 12 inches on center max.

4. Round exposed duct: hang from twin half round bands and rods, or as otherwise detailed.

2.4 BUILDING ATTACHMENTS

A. Structural Steel Connectors:

1. C-Clamp style:

   a. FM approved, U.L. listed, steel or malleable iron C-clamp with hardened set screw and lock nut, tapped for rod size, typically eccentrically loads structure.
   b. Hanger rod bypasses structure: MSS SP-58 type 19.
   c. Hanger rod in line with set screw: MSS SP-58 type 23.

2. Center Loading Beam and Channel Clamp Style:

   a. Forged or formed steel or malleable iron construction, beam clamps with connection for concentrically loading structure, of types as required by loading and configuration.

   b. MSS SP-58 types 21, 27, 28, 29, and 30.

3. Pivoting or Adjustable Connection Style:

   a. Structural welding lug with forged steel clevis, side beam bracket, or other appropriate pivoting beam clamps as required for sloped steel.
   b. Use for sloped steel, where thermal movement requires pivot, where seismic controls requires non-moment building connection, and elsewhere as required.
   c. MSS SP-58 types, 21 or 22 with 16 or 17, 34, 57 with 14, etc...

4. Provide products by one of the following manufacturers:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
   c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

B. Existing Concrete Connectors:

1. Self-energizing tapered expansion bolt/sleeve: GSA specification FF-S-325, Group II, Type 3, Class 3, UL Listed, FM approved, complete with split expansion sleeve, washer, and hex head nut; similar to “Rawl Lok/Bolt” by Rawlplug.

2. Dual-Interlocking Expansion Wedge Stud: GSA specification FF-S-325, Group II, Type 4, Class 1, UL Listed, FM approved, complete with split expansion sleeve, washer, and hex head nut; similar to “Rawl-Stud” by Rawlplug.

3. Dual-Interlocking Expansion Wedge Threaded Rod Anchors: UL Listed, FM approved, complete with split expansion sleeve; similar to “Rod Hanger Wedge Anchor” by Rawlplug.

4. Provide products by one of the following manufacturers:

   a. Hilti, Inc.; Tulsa, Oklahoma, or equal
   b. Ramset/Red Head; Michigan City, Indiana, or equal
   c. Rawlplug Co. Inc.; New Rochelle, New York, or equal.

C. Hollow Masonry, Hollow Concrete, Pre-cast Plank Connectors:

1. Toggle Bolt Type: GSA specification FF-B-588C,Type 1, Class A with ultimate load capacities meeting or exceeding load capacities for hollow concrete block in conformance with ASTM C-90; similar to “Rawl Toggle Bolt” by Rawlplug.

2. Epoxy/Screen tube type: Manufacturer’s load rated epoxy resistant to the chemical exposure of the application and capable of developing the ultimate strength of the threaded rod used, with stainless steel screen tube designed specifically for use with epoxy anchors in hollow masonry. Use manufacturer’s recommended mixing/injection device. Similar to the “Foil-Fast”, “Chem-Fast”, and “Chem-Stud” systems by Rawlplug.

3. Through bolt, nuts, square plate steel washer (thickness equal to half bolt diameter, width equal to six diameters minimum).

4. Provide products by one of the following manufacturers:

   a. Hilti, Inc.; Tulsa, Oklahoma, or equal
   b. Ramset/Red Head; Michigan City, Indiana, or equal
   c. Rawlplug Co. Inc.; New Rochelle, New York, or equal.

D. Flanged Connectors:

1. Applicable for attachment to building steel, concrete, or wood.

2. Malleable iron flange base, with central threaded hole for connection to threaded rod and symmetrical side hole for securing to structure with appropriate fasteners, typically used with split rings, similar to “Model No. 365M" by ERICO/Michigan Hanger.

3. Pipe Stanchion Flanged Support Plate and Floor Stand: ASTM A-536 ductile iron support plate with 1-inch rolled thread adjustment stud and nut, or 1/4-inch carbon steel base plate welded to schedule 80 threaded steel pipe, designed for use with Stanchion Saddle style supports described above; similar to "PS1236 Redi-Jack Pipe Support" by Red Hed.

4. Provide products by one of the following manufacturers:

    a. B-Line Systems, Inc., Highland Illinois, or equal
    b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
    c. Red Hed; Lincoln, Rhode Island. or equal.

2.5 ROOF MOUNTED SUPPORTS

A. Roof Curbs: Double shell, galvanized steel, welded and painted, 1-1/2 inch minimum thickness, with pressure treated wood blocking, braced and fully insulated with rigid fiberglass insulation (3 PCF). Includes gasket at top of curb for airtight seal between curb and ventilator or fan. Provide raised cant, recessed, or flanged curb bottom to suit roof construction and insulation.

1. Steel Thickness: 20 gauge up to 36 inches, 18 gauge 38 to 72 inches, and 16 gauge over 72 inches. Provided with reinforcing and heavier gauge as required to adequately support weight load on curb; coordinate exact size with specified equipment.

2. Minimum height of curbs above finished roof:

    a. Refer to Equipment Schedules for roof curb height, but never less than 14 inches.
    b. For sloped roof curbs, curb of height sufficient to maintain bottom edge of supported equipment at above specified height.

3. Provide with pressure treated blocking, through bolted to structure with stainless steel fasteners, as required bringing base of curb into proper plane for installation. Blocking minimum width to be no less than blocking height. Refer to Division 1 section "Roof Rough Carpentry" for additional details.

4. Where required for specified vibration isolation system, provide curbs with integral restrained spring isolation system as described in more detail, refer to Section 23 05 43 - Mechanical Vibration and Movement Control.

5. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thybar or equal

B. Pipe Curb Assembly: Similar to Roof Curb specified above, equipped with fully welded curb cap top cover of heavy gauge aluminum (12ga), galvalume (16ga), or stainless steel (16ga) construction with integral curb counter flashing, raised flashing collars with replaceable neoprene pipe boot counter flashing secured with stainless steel clamps, size and number of pipe and conduit openings as required. Similar to Pate PCA curb with PCC-C custom curb cap package.

1. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thybar or equal

C. Equipment Support Rails: Double shell galvanized steel, 14 gauge minimum, fully welded with solid bottom and ends. 2 inch x 8 inch treated wood top blocking, minimum 14 inches high above finished roof, minimum 2 inch turned out flange at bottom, C-channel top cap counter-flashing over blocking. Length to be the longer of 12 inches longer than equipment served or extended past equipment to next building structural support member, factory certified for weight of intended equipment at spacing of structure below, with reinforcement and heavier gauge as required. Units longer than eight feet may be field spliced with bolts and splice plates. Provide galvanizing paint at welds and field splices. Include top cap and integral base with raised cant where required. Provide raised cant, recessed cant, or flanged curb bottom to suit roof construction and insulation. Similar to custom "ES-5A" by Pate.

1. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thybar or equal

D. Non roofing penetration exterior equipment supports:

1. Roof Stanchion or Strut Supports:

    a. Materials: military grade weatherproof reinforced nylon, with four
    b. Load capacity: Each base can support up to 600 lbs
    c. Adjustable Height: 3.2”-5”
    d. Base roof surface area: 38 square inches (7” dia).
    e. Bases connect to standard unistrut
    f. Basis of Design: Green Link Eco-Engineering “Knucklehead”

E. Non roofing penetration exterior duct supports:

1. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and 4 inches larger than support stand base. Provide base sizes load rated for distributing the supported weight at less than two pounds per square foot. Include snow load as shown on code compliance drawings. Provide detailed duct support layout drawings and support size / weight / roof loading calculations in submittal for all non roofing penetration exterior duct supports.

2. Provide loose laid support stands with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) or stainless steel deck base, with socket securing Hot Dipped galvanized or Stainless Steel channel duct support superstructure. Include mechanically bolted support angle clips, and cross member channels for both gravity support and uplift resistance. All fasteners to be stainless steel. Provide with radiused edges to protect roofing, drainage holes, and bolt down holes as required by seismic restraint system.

3. Sliding clamped height adjustment supports, adjustable as required to achieve duct slope and roof clearance required.

4. Similar to "PPH-D Enclosed" by PHP. Provide products by one of the following:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. RTS by Eberl Iron Works, Buffalo, NY, or equal
   c. Miro Industries, Inc., Murray, Utah, or equal
   d. Portable Pipe Hangers (PHP) Systems and Design, Houston, Texas, or equal

F. Non roofing penetration pipe supports:

1. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and 4 inches larger than support stand base. Provide base sizes load rated for distributing the supported weight at less than two pounds per square inch. Provide detailed piping support layout drawings and support size / weight / roof loading calculations in submittal for all non roofing penetration pipe supports.

2. 2 inch nominal and smaller pipe:

   a. Loose laid pipe support stand with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) deck base / roller housing, with load rated roller saddle running on nylon or SS bearing shaft. Provide with drainage holes, and bolt down holes as required by seismic restraint system.

   b. Provide matching height adjustment spacers to achieve pipe slope required.

   c. Manufacturer load rated as required.

   d. Similar to "Pillow Block Pipestand Model 3-R" by Miro Industries, SS8-R by PHP.

3. Provide products by one of the following:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. RTS by Eberl Iron Works, Buffalo, NY, or equal
   c. Miro Industries, Inc., Murray, Utah, or equal
   d. Portable Pipe Hangers (PHP) Systems and Design, Houston, Texas, or equal

2.6 EQUIPMENT SUPPORTS

A. Provide custom designed hangers and supports to properly and resiliently support all contract equipment as required by special circumstances encountered. Suspend from above or support from below as shown on drawings and as required.

B. Use structural carbon steel plate and shapes, secured by welding or bolts as required.

C. Use load rated fasteners full size of the component attachment points unless specifically requested and approved otherwise.

D. Provide lateral bracing as required minimizing potential for sway.

E. Fabricate as required to transmit loads and reaction forces to structure, in accordance with applicable details and layouts shown on Drawings, and as approved by Architect. Submit load calculations and fabrication details for approval for all such supports including verified coordinated dimensions, weights, etc., of mechanical component, support component, and building structure proposed.

2.7 MISCELLANEOUS COMPONENTS AND ACCESSORIES

A. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

B. Threaded Rods, Bolts, Nuts, Washers, Metals, Hardware, and Miscellaneous Assembly Components:

1. Provide manufacturer's load rated fasteners with size, strength and corrosion resistance as required for the application.

2. Rods, bolts, machine screws: rolled forged ANSI B1 Class 2A or better thread, bolts and screws with heads as required by the application, length as required for full thread engagement of but minimal projection past receiving connector including building attachment, (double) nuts, equipment attachment, etc.

3. Nuts: heavy pattern where space permits and where subject to repeated operation, ANSI B1 Class 2B or better thread.

4. Washers: US pattern where space permits, SAE pattern otherwise, with toothed or split lock washer when attached to equipment with moving or vibrating parts.

5. Sheet metal screws: self drilling, thread forming, hardened steel (hardened SS as required), load rated screws with hex heads designed for power driving

6. Structural Steel: ASTM A 36/A 36M, carbon-steel, black and galvanized, and/or series 300 Stainless Steel plates, bars, angles, channels, and other shapes in thickness and size as required for load.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which hangers and supports are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When Contractor confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Contractor.

2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.

3.2 GENERAL INSTALLATION

A. Provide complete hanger and support systems for piping and ductwork systems and equipment, including all necessary attachments, fasteners, threaded rods, bolts, miscellaneous hardware, and associated work as required.

B. Provide specified products, installed in accordance with applicable sections of this specification, in accordance with the manufacturer's recommended installation instructions, and as detailed on the Drawings.

C. Support pipe, duct, and equipment from the building structure.

1. Provide approved miscellaneous support structure as required to attach hangers and supports to building structure in conformance with all applicable standards and related specification sections.

2. Do not use chain, perforated hanger strapping or band, wire hangers, or kinked, bent, or otherwise damaged hangers and supports.

3. Do not support one pipe from another, one duct from another, pipe from duct or equipment, or any similar combination.

4. Install lateral bracing with pipe hangers and supports as required to prevent swaying.

5. Provide special hangers and supports as shown on the drawings, as required to suit existing conditions, and as required for proper installation of equipment.

D. Coordinate the installation with applied fireproofing and where possible install attachments to structure prior to fireproofing. Where prior installation is not possible, repair fireproofing as required.

1. Repair or replace any fireproofing removed or damaged during installation of components.
2. Ensure repaired or replacement fireproofing continuously matches or exceeds rating of adjacent fireproofing and ensure that all warranties are maintained.

E. Load Distribution: Install hangers and supports so that live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.3 PIPE HANGER AND SUPPORT INSTALLATION

A. Comply with MSS SP-58 and MSS SP-89 and as specified below. Install hangers, supports, clamps, and attachments as required properly supporting piping from the building structure.

B. Trapeze Pipe-Hanger Installation: Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from manufactured slotted channel system or structural shapes selected for loads being supported.

C. Size piping attachments for insulated piping to fit outside insulation. Size piping attachments for un-insulated piping to fit outside diameter of pipe.

D. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping. Provide for slope of trapeze supported piping systems with adjustable individual piping attachments.

E. Accommodate thermal movement of piping systems.

1. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

2. Provide rods of sufficient length for ample swing. Hang rods from high points to allow maximum swing.

3. Hang piping so that rods are vertical at the design temperature.

4. Where length of rod and thermal expansion combine to cause more than 4 degrees angular movement of rod (or 1 inch lateral movement in a 12 inch rod), provide suitable linkage to permit swing and limit rods to tensile loading only, or, provide pipe roll.

5. Where length of rod and thermal expansion would combine to cause more than 10 degrees angular movement of rod (or 2 inch lateral movement in a 12 inch rod), provide pipe roll.

6. More thermal movement is expected as the straight line distance from piping anchor points increases. Unless unusually long hanging rod length allows swing as indicated above, provide pipe roll hangers and supports at or above the following distances from piping anchor points indicated on drawing or installed in field. Deviations from below values subject to pre-approval:

Piping Service		Distance from Anchorage
a.	Individual Copper Heating Service.	35 ft.
b.	Trapeze Copper Heating Service.	20 ft
c.	Individual Steel Heating Service.	60 ft.
d.	Trapeze Steel Heating Service.	50 ft

F. Pipe Hangers and Supports Spacing (Maximum):

1. Provide hanger or support as close as possible to and within 24 inches of any elbow.

2. Provide hanger or support on branch pipe within 24 inches of main at takeoff / tee.

3. All Horizontal / Sloped Heating and Cooling Piping Systems:

Piping Material		Maximum spacing of hangers
a.	Copper ¾ in. and smaller	5 ft.
b.	Copper 1 in. and 1-¼ in.	6 ft.
c.	Copper 1½ in. and larger	8 ft.
d.	Steel 1¼ in. and smaller.	7 ft
e.	Steel 1½ in.	9 ft.
f.	Steel 2 in. and larger	10 ft.
g.	Annealed copper	3 ft.
h.	Flexible piping or hose	Continuous

4. Vertical Piping:

a.	Steel and Copper 1¼ in and smaller	Two per floor level.
b.	Steel and Copper 1½ in and larger	One per floor level.

G. Insulated Piping

1. Center insulation shields at piping attachments and secure shield from lateral movements by wrapping PVC tape around circumference of piping insulation and shield at both ends of shield.

2. At all piping attachments, provide piping insulation protection system of strength and configuration required to guarantee integrity of pipe insulation and associated vapor barrier. Refer also to SECTION 23 07 00 INSULATION.

3.4 BUILDING ATTACHEMENTS INSTALLATION

A. Threaded Rod for Hangers:

1. Double nut each end of each rod. Threaded clamp, turnbuckle, etc. counts as one nut.

2. Rod size for individual pipe hangers and two rod / two pipe or duct trapeze style supports:

Rod size:	for Pipe size:	for Duct size:
3/8”	2” and smaller.	48” wide to 72”
1/2”	2-1/2" and 3".	Over 72” wide
5/8”	4" and 5".	
3/4”	6".	

3. For multiple pipe or duct trapeze style supports with two rods for more than two pipes or two or more ducts, size rods according to manufacturers recommended safe working loads taking into account total hung weight, 200 pound live load, as well as capacity of structure; each rod not smaller than size shown above for largest pipe or the sum of the duct width in the trapeze. Submit details of all such supports and connectors for approval before construction, including schedule of proposed sizes and capacities.

B. Fastener Systems: Provide screws, bolts, approved anchors, etc., to secure piping, duct, equipment, supports, and miscellaneous components and accessories to structure. Nailing not permitted.

1. Install all fastener systems and anchorage in strict accordance with fastener manufacturer’s instructions and as otherwise indicated below.

2. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 3” and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

3. Minimize eccentric loading of structure as follows:

   a. For paired point loads eccentrically suspended (C-clamp attached supply and return pipes, etc), suspend from opposite edges of structural member.

   b. For point loads over 400 pounds, use center loading beam clamps or other structurally concentric building attachment, and confirm proposed configuration with Engineer by submittal.

4. For connections cast in place to new concrete, assume concrete strength as specified. Do not apply loads to freshly cured concrete until written approval is received from contractor responsible for concrete strength.

5. For connection to existing concrete:

   a. Connect only to sound concrete free of evidence of deterioration.

   b. Do not install connections or apply loads to recently cast curing concrete until written approval is received from contractor responsible for concrete strength. Use compressive strength certified by ASTM approved test results.

   c. For older existing concrete and in the absence of ASTM approved tests certifying otherwise, assume a concrete compressive strength of $f'c = 3000$ psi.

d. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use powder-actuated fasteners in precast concrete or in pull-out tension.

6. For connection to wooden structures: Apply NDS criteria to all structural wood connections. Unless grade stamped better, use #2 SPF / white wood strengths for fastener loading calculations.

3.5 DUCT HANGERS AND SUPPORTS

A. Install per SMACNA duct manual and as modified by the requirements of this section.
B. Provide support spacing per building structural system but not greater than 8 feet. Provide extra support structure as required.

3.6 ELECTRICAL WORK HANGER AND SUPPORT INSTALLATION

A. Refer to Division 26 complete.

3.7 ROOFTOP SUPPORT INSTALLATION

A. Rooftop Supports for Piping, Duct, and Service Access:

1. Non-roofing penetration supports:

a. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume that cleaning area of roofing at each support is required with installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and minimum 4 inches larger than support stand base.

b. Attach supports to roof as required for seismic, wind, and thermal movement control with compatible rooftop fasteners through holes drilled in bottom of pipe stand pitch pan at time of installation. Fill pitch pan with asphalt material or cement as directed to seal areas around fasteners watertight.

c. Center supports beneath duct or pipe so cradle allows pipe to be squarely over and through cradle pipe stand. Align platform supports adjacent to equipment requiring service access as required provided optimized access.

d. Adjust to desired height insuring level platforms, level horizontal bars, proper longitudinal pitch for pipe and duct, and even load distribution among all supports.

e. Set equipment in support without dropping or causing undue impact. Assemble platform grating and secure to superstructure.

f. Assemble duct and piping restraints and handrails, and make final adjustments to alignment and level.

2. Curb-Mounted-Type Pipe and Duct Supports: Assemble components and mount on permanent, stationary roof equipment support rails or curb. Equipment Support Rails

B. Roof Curbs, Pipe Curbs, and Equipment Support Rails:

1. Maintain existing roof warranties. Contractor is responsible for the installation of all Roof Curbs, Pipe Curbs, and Equipment Support Rails for their equipment complete. Employ the services of a qualified subcontractor specializing in roofing work and certified by the carrier of all new or existing roofing warranties to perform warranty compliant roofing work as required for this project. Employ the services of a qualified subcontractor specializing in structural work to perform structural roof support work as required for this project. Use their services to cut roof openings, provide structural support and installation of Roof Curbs, Pipe Curbs, and Equipment Support Rails, and to patch roofing cuts complete. Refer to SECTION 01 73 00 - EXECUTION for additional requirements and procedures for cutting openings in existing roofs and roof decks.

   a. If existing roofing is out of warranty, provide minimum two year warrantee for roofing work of this contract.

2. Provide larger of curb height scheduled on Drawings or as recommended by equipment manufacturer, but not less than 14 in. above finished roof. Refer to required installation details and provide additional curb height where finished roof surface is above curb mounting flange.

3. Provide all roof curbs required for all rooftop-mounted equipment in Contract.

   a. Provide structural support for roof deck around all roof curbs and roof deck penetrations 12 inch x 12 inch and larger, unless specifically indicated otherwise elsewhere on the Contract Documents. Refer to drawings for additional support details around roof openings.

   b. Refer to Section 06 10 26 – ROOFING ROUGH CARPENTRY, for additional wood blocking requirements.

   c. Verify exact size and location and set and secure unit to roof.

   d. Set and secure curb or support level as required by manufacturer of equipment served. Provide tapered shims as required up to 3-1/2 inch thick. If structure slopes more than 3-1/2 inch over length of curb, provide sloped curb to match structure so as to minimize shims. Provide corrosion-resistant fasteners as required to secure curbs to deck or structure, coordinate with subsequent roofing requirements.

   e. Coordinate roof openings and set and secure curbs in ample time so as to avoid delay in construction schedule.

   f. Coordinate in curb access and rooftop equipment sound transmission mitigation:

      1) Coordinate roof deck removal within curbs in all cases with Architect, Owner, Construction Manager and all affected trades as required to optimize access and sound transmission prevention.

2) In general, for exhaust fan, roof top hood, pipe, and combination equipment / pipe penetration curbs, provide for below curb service access by complete removal of roof deck internal to curb throat free area.

3) In general, for Roof Top Air Handling Units, provide in curb sound attenuation and acoustically rated roof deck penetrations as specified in Section 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL.

4) Coordinate special circumstances requiring exceptions to above with Architect and equipment manufacturers.

g. Prevent water entry into building. Provide roofing work as required to flash curbs. Provide counter flashing and gaskets with curb mounted equipment as required to keep water from entering curb. Provide temporary caps as required until permanent installation is made.

h. Install Curb Adapters in manner similar to how supported equipment is secured to curb. Provide complete with closed cell gaskets, minimum two stainless steel fasteners per side and additionally as required for equipment support.

3.8 METAL FRAMING AND EQUIPMENT SUPPORT INSTALLATION

A. Provide miscellaneous metal, beams, angles pipe bars, structural steel shapes, bases, braces, etc. accessories required to attach hangers and supports to walls, floors, structural members, etc. in conformance with Section 05 50 00 – "METAL FABRICATIONS".

B. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

C. Custom Hangers and Supports: Install as required by special circumstances encountered, in accordance with applicable details and layouts shown on Drawings, and as approved by Architect.

D. Provide lateral bracing to prevent swaying for equipment supports.

E. Provide vibration isolation, and thermal movement capability for hangers and supports. Refer to Sections 23 05 43 - MECHANICAL VIBRATION AND MOVEMENT CONTROL.

F. Grouting: Place grout under supports for equipment and make bearing surface smooth.

G. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

3.9 ADJUSTING

A. Adjust all hangers and supports after installation of piping and associated equipment to distribute loads equally on attachments and to achieve proper pitch for the applicable piping system.

B. Trim excess length of continuous-thread hanger and support rods as required - avoid hazardous protrusion.

3.10 PAINTING AND TOUCHUP

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes mechanical movement controls for all mechanical equipment and components, piping, and duct work provided or modified as a part of this Project and as noted on the drawings, whether movement is from sound, vibration, thermal, or other sources including (but not limited to):

1. Vibration isolation hangers and mounts for equipment, piping, and ductwork.
2. Flexible piping and flexible piping connections.
3. Restrained vibration isolation roof-curb rails.

1.3 DEFINITIONS

A. IBC: International Building Code.
B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Provide mechanical sound, vibration, and movement control for all mechanical equipment, piping, duct work, and other components provided or modified as a part of this Project, and as shown on the Drawings. Mount on or suspend from vibration isolators to reduce transmission of vibration and mechanically transmitted sound to building structure. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflections.

1. Correct any variance or non-compliance with specified requirements in manner directed by Architect.

1.5 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data for the following:

a. Catalog cuts and data sheets on vibration isolators, isolation bases, and isolation curbs. Indicate rated load, rated deflection, and overload capacity for each device. Annotate to indicate application of each product submitted and compliance with requirements.

b. Catalog cuts and data sheets on sound attenuation components used. Indicate style, material, and attenuation characteristics for each device or product.

c. Schedule of flexibly mounted equipment, referencing drawings by number. Include number, type, and loading of all isolation components.

2. Shop Drawings

a. Submit details of following items

1) Equipment bases including dimensions, structural member sizes and support point locations. Equipment bases shall include all curbs for rooftop air handling units.

2) Isolation hangers and systems for ceiling hung equipment, piping and ductwork.

3) Mountings for floor supported equipment, piping and ductwork.

4) Complete flexible connector details.

b. Indicate deflections and model numbers on all hanger, mounting or pad drawings including any other specified requirements.

c. Provide in tabular form spring diameters, rated loads and deflections, heights at rated load and closed height for all springs shown in submittals.

C. Informational Submittals:

1. Product Certificates:

a. Contractor Statement of Responsibility: Refer to Division 01 Section, “Quality Requirements”.

D. Closeout Submittals:

1. Contract Closeout Submittals: Comply with requirements of Section 01 73 00, including submission of operating and maintenance instructions as item in "General Construction Instructions" manual described in that section.

1.6 COORDINATION

A. Coordinate layout and installation of vibration isolation and movement control devices with other construction that penetrates ceilings or is supported by, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

C. Coordinate design of restraints and vibration isolation design with expansion compensation systems.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.

B. Factory Finishes: Provide manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

C. Where neoprene is referred to and used in vibration isolation components, it shall be bridge-bearing grade premium neoprene of the durometer hardness grade and size specifically recommended by the design make manufacturer for both maximum vibration isolation and load rated for the specific application.

D. Hangers

1. Neoprene Hangers: Rigid steel frames containing neoprene element.

a. Minimum 1-1/4-inch thick neoprene element on bottom with projecting bushing preventing steel-to-steel contact.
b. Minimum static deflection of 0.20-inch.
c. Boxes not articulated, clearance hole in neoprene element to allow non-moment bearing connection at structural support.
d. Configured for threaded rod, eye bolt, or strap connections as required.
e. Basis-of-Design Product: Mason Industries, Inc.; Type HD.

2. Type A Hangers: Rigid steel frames containing minimum 1-1/4-inch thick neoprene elements at top and steel spring with general characteristics as specified for Spring Isolator above seated in steel washer reinforced neoprene cup on bottom.

a. Neoprene element and cup have neoprene bushings projecting through steel box.

b. Boxes not articulated as clevis hangers nor neoprene element stacked on top of spring in order to maintain stability.

c. Spring diameters and hanger box lower hole sizes large enough to permit hanger rod to swing through 30-degree arc from side-to-side before contacting cup bushing and short-circuiting spring.

d. Include hanger drawing showing 30-degree capability.

e. Basis-of-Design Product: Mason Industries, Inc.; Type 30N.

3. Type B Hangers: Similar to Type A Hangers specified above with following modifications.

a. Pre-compressed and locked at rated deflection by means of resilient up-stop to keep piping or equipment at fixed elevation during installation.
b. Designed with release mechanism to free spring after installation is complete and hanger subjected to full load.
c. Deflection clearly indicated by means of scale.
d. Include drawing of hanger showing 30-degree capability in Submittals required in Part 1 above.
e. Basis-of-Design Product: Mason Industries, Inc.; Type PC30N.

4. Vibration Hangers: Similar to Type A Hangers specified above with following modifications.

a. Provided with weldless eyebolts top and bottom to facilitate attachment to flat duct straps.
b. Basis-of-Design Product: Mason Industries, Inc.; Type W30N.

E. Piping Vibration Isolation and Movement Control

1. Flexible Equipment Piping Connectors: Connections rated for a minimum of 1/8-inch compression and elongation, 1/2-inch lateral, and 5-degree angular misalignment. Provide connectors with flanged, grooved, or threaded end connections meeting specified requirements for fittings and sized to match equipment connected with integral, tapered, concentric size reductions where equipment and piping are not the same size.

a. Provide one of the following flexible connector types:

1) Flex Hose Type: Stainless steel annular corrugated closed pitch bellows with braided stainless steel wire reinforcing protective jacket, internally and externally continuously TIG welded to end fittings. Minimum 150 psig working pressure at 250 degrees F operating temperature.

a) Design Make: “SECF” by Southeastern Hose or similar product by Flex-Hose.

2) Spherical Reinforced Elastomeric Type: minimum pressure range of 16 in Hg. vacuum to 150 psig over full temperature range of -20 deg. F to +240 deg. F. Connectors have metal flanged ends tapped to mate with standard 150# or 300# companion flanges, elastomer compatible with the working fluid, and high strength low stretch polymeric reinforcement. Provide complete with pipe anchors or control units as required for system pressure control.

a) Design Make: "Safeflex" by Mason or "Flexzorber" by Flex-Hose.

3) Flexible Mechanical Connector Type: three minimum flexible mechanical grooved couplings, as specified in Section 23 21 13 – HYDRONIC PIPING, installed adjacent to equipment and before first hanger. May be arranged between tapered increasers, check valves, flow measuring stations, etc., or separated by short pipe nipples.

a) Design Make: Style 77 flexible couplings by Victaulic.

2. Split Wall Seals: 2 bolted pipe halves with minimum 3/4-inch thick neoprene sponge centered to inner faces with seal tightened around pipe to eliminate clearance between inner sponge face and piping and installed to project minimum of 1-inch past either face of wall.

a. Concrete may be packed around seal to make it integral with floor, wall or ceiling if seal is not already in place around pipe prior to construction of building member.
b. Where temperatures exceed 240 deg F, 10# density fiberglass may be used in lieu of sponge.
c. Basis-of-Design Product: Mason Industries, Inc.; Type SWS.

F. Curb or Rail Mounted Rooftop Equipment: Mounted on spring isolation curbs with sheet metal "Z" section lower member supporting upper floating section and upper frame providing continuous support for equipment and captive to resiliently resist wind forces.

1. All directional neoprene snubber bushings minimum of 1/4-inch thick.
2. Steel springs laterally stable and resting on 1/4-inch thick neoprene acoustical pads.
3. Hardware plated and springs provided with rust-resistant finish.
4. Curbs waterproofing consists of continuous galvanized flexible counter flashing nailed over lower curbs waterproofing and joined at corners by EPDM bellows.
5. All spring locations have access ports with removable waterproof covers.
6. Lower curbs have provision for 2 inches of insulation.
7. Curbs have OSHPD anchorage pre-approval "R" number certifying seismic capability.
8. Basis-of-Design Product: Mason Industries, Inc.; Type RSC (curb) or Type RSR (rail).

2.2 ACOUSTICAL ATTENUATION COMPONENTS

A. Submit published sound attenuation data for all sound attenuation components generated by a certified aero-acoustical testing laboratory in full accordance with ASTM E 477, Standard Method of Testing Duct Silencers. Provide all attenuation components complying with NFPA 90-A requirements.

B. Duct / Pipe Lagging: 2mm thick barium sulphate-loaded vinyl sheet bonded to fiber scrim reinforced aluminum coating on outer side and to 1-inch thick mineral wool or fiberglass batting decoupling layer on the other side. Inner face covered with fiber skrim reinforcing. Minimum 1lb. per square foot weight. Acoustical performance at least that of the design make.

1. Basis-of Design Products: Kinetics Noise Control, Inc.; Type KNM-100ALQ and Sound Seal; B-10 LAG.

C. Damping Compound: Non-asphaltic viscoelastic vinyl based latex emulsion designed for application to metal surfaces for the purpose of damping acoustical vibrations and with damping efficiency at least that of the design make.

1. Basis-of Design Products: Kinetics Noise Control, Inc.; Type KDC-E-162 and Sound Seal; VBD-10.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and movement control devices for compliance with requirements for installation tolerances and other conditions affecting performance. Notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

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

2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.

B. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 VIBRATION, SOUND, AND THERMAL MOVEMENT CONTROL INSTALLATIONS

A. Install all vibration isolators and acoustical attenuators in strict accordance with manufacturers written instructions and all submittal data. Coordinate installation to avoid rigid contact with building.

1. Install without any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

2. Do not make rigid connections between equipment and building structure that degrade noise and vibration control system specified.

3. Do not install any equipment, piping, duct, or conduit with rigid connections to building or other support structure unless no isolation is specifically called for. "Building" includes, but is not limited to, roof deck, floor/ceiling/roof slabs, beams, joists, columns, studs and walls.

    a. For exterior ground or frame mounted equipment

4. Identify any conflicts which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions to Architect / Engineer prior to installation. Corrective work required by conflicts after installation at Contractor's expense.

5. Correct, at no additional cost, all installations deemed defective in workmanship and materials at Contractor's expense.

3.3 PIPED EQUIPMENT INSTALLATIONS

A. Condensing Units, other Base Mounted Compressor-driven Equipment:

1. Isolate equipment from structure using vibration isolation system specifically designed for the installation and having deflection tuned to the mass and frequency of the rotating or vibrating machinery to minimize the propagation of the vibrations.

    a. Unless specifically detailed otherwise, isolate equipment having 1 KW motors and larger and/or having a rotating speed of any component under 1800 rpm using restrained spring isolators with minimum 2” deflection, on inverted saddles as required to lower height, all mounted on elastomeric pads.

    b. Unless specifically detailed otherwise, isolate equipment having under 1 KW motors and having a rotating speed of all components 1800 rpm or over using restrained elastomeric isolators with minimum 0.3” deflection, on inverted saddles as required to lower height.

B. Hydronic Equipment

1. Vibration Isolation of Hydronic Equipment:

    a. Isolate all upper floor, suspended, and roof mounted hydronic equipment with vibration producing parts from structure using vibration isolation system specifically designed for the installation and having deflection tuned to the mass and frequency of the rotating or vibrating machinery so as to minimize the propagation of the vibrations.

    b. Where piping connects to mechanical equipment with vibration producing parts, including air-handling equipment with hydronic or refrigerant based heat exchange coils, install elastomeric spherical or mechanical coupling flexible connection joints.

1) Where elastomeric based flexible connector joint is not suitable for service (example: refrigerant service), provide flexible stainless steel hose. Install hoses:

a) On equipment side of shut-off valves.
b) Parallel to rotating equipment shafts, wherever possible.
c) Perpendicular to anticipated thermal movement.
d) Where movement in two axes is anticipated, install hose of sufficient length to form elbow or install two hoses with elbow fitting between.

3.4 AIRSIDE INSTALLATIONS

A. Vibration Isolation of Air Handling Equipment:

1. For all roof top air handlers above occupied spaces unless otherwise noted or scheduled on drawings, provide acoustical attenuation within curb below rooftop air handlers as follows:

a. Coat deck within curb with damping compound.

b. Seal around duct, pipe, conduit, fastener, etc., penetrations air-tight to maintain air and vapor barrier, typically with 60mil EPDM roofing membrane sealed to deck and cut for a tight stretch fit to pipe or duct. Caulk holes. Fill deck corrugation flutes at edges with fire rated expanding urethane foam and set / seal EPDM into wet foam.

c. For air handlers with total motor power less than 5KW unless specified otherwise on the drawings:

1) Fill entire area within curb with fire rated expanding urethane foam to a minimum depth of 5 inches from the top of the deck flutes.

d. For air handlers with total motor power 5KW and above and/or as specifically called for on the drawings:

1) Overlay sealed deck with 3” flexible fiberglass batt insulation.

2) Overlay insulation with one layer of ⅝” thick moisture and mold resistant gypsum board (GWB) fitted 1” from curb perimeter and duct/piping penetrations with annulus filled with fiberglass batt, sealed and taped at all joints with damping compound and skrim joint tape.

3) Overlay GWB with acoustical duct/pipe lagging fitted closely to duct, pipe, and curb perimeter and seal to each in accordance with manufacturer’s directions.

4) Provide acoustical duct and piping penetrations both through unit bottom and roof deck.

B. Vibration Isolation of Ductwork:

1. Isolate all ducts from mechanical air handling equipment using flexible connectors.

2. Isolate all rectangular duct runs having average air velocity of 1200 fpm or more from building structure using Type A or Type B hangers or spring floor supports. Provide minimum of 0.75-inch spring deflection.

3. Unless internally lined, provide damping compound on all rectangular duct hung over occupied spaces and having average air velocity of 1000 fpm or more as required to eliminate duct rumble.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 43

SECTION 23 05 53 - IDENTIFICATION FOR HVAC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Stencils.
5. Valve tags.
6. Equipment Location Ceiling Markers

1.3 SUBMITTALS

A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit "**As-Specified Verification Form**" (attached to SECTION 01 33 00 - Submittals) in lieu of "Product Data" identified below in this Article.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.

B. Action submittals:

1. Submit manufacturer's data sheets for all proposed products demonstrating compliance with specifications.

C. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittal.

a. If "**As-Specified Verification Form**" submittal is approved, also include product data for all identification components used.

2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.

3. Valve Schedule. - Refer to Paragraph 2.6.C.

1.4 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 locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Paint: Refer to DIVISION 09.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brimar Industries, Inc. or equal.
2. Campbell International (Ltd.), or equal.
3. Craftmark Identification Systems, Fort Worth, Texas, or equal
4. EMED Company, Inc., Buffalo, New York , or equal
5. Seton Name Plate Company, New Haven, Connecticut, or equal

2.2 LABELS

A. Equipment Labels:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware, or multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Colors:

a. Brass Labels: black in-filled letters on brass background
b. Plastic Labels: white letters on black plastic background

4. Able to withstand temperatures up to 160 deg F. continuously.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless-steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Equipment Label Content: Include equipment's Drawing designation or unique equipment number and equipment function.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive. Secure in place with full circumference tape wrap.

C. Pipe Label Contents: Include identification of piping service using abbreviations indicated below, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction (flow direction arrow circumference tape preferred).

2. Lettering Size: In accordance with ANSI 13.1 and as follows:

Outside diameter:		Letter Height:
a.	2” or less	¾”
b.	6” or less	1.25”
c.	10” or less	2.5”
d.	Over 10”	3.5”

3. Pipes too small to be directly labeled: provide hanging equipment tag with ½” lettering. Outside diameter indicated is to outside of pipe insulation on insulated piping.

D. Piping Systems: Identify the following systems as indicated:

1. Condensate (LPC)
2. Refrigerant Liquid (RL)
3. Refrigerant Suction (RS)
4. Refrigerant Hot Gas (HG)
5. Heating Hot Water Supply (HWS)
6. Heating Hot Water Return (HWR)
7. Low Pressure Steam Supply (LPS)

8. Low Pressure Steam Return (LPR)
9. Condensate Drain (CD)

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Colors: Letter color, black; background color, white.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: One inch for viewing distances up to 60 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service, duct size (inches x inches clear inside dimensions, side labeled first), and an arrow indicating flow direction.

1. Unless specifically indicated otherwise on Drawings, use duct service designations below, where (SYSTEM) is the equipment served:

    a. (SYSTEM) SUPPLY AIR
    b. (SYSTEM) RETURN AIR
    c. (SYSTEM) OUTSIDE AIR
    d. (SYSTEM) MIXED AIR

2. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts (1 inch for each five feet viewing distance).

1. Stencil Material: Durable, thin, as required to make crisp stenciled pattern.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.
4. Stenciled Label Contents: as described in pipe and duct labels above.

2.6 VALVE TAGS

A. Valve and Hydronic Specialty Identification: Provide 1-1/2 inchinch diameter brass tags, 0.032-inchminimum thickness, with predrilled or stamped holes for attachment with #16 brass jack chain, factory engraved or stamped with 1/2-inch letters for piping system abbreviation and 1/2-inch numbers, with black in fill, legend as described below.

1. Stamp "H" and valve number for each main, riser, zone, and branch heating valve.
2. Stamp "S" and strainer number for each strainer.
3. Provide a special tag at thermal expansion tank(s) shut off valve with legend as follows: "Always keep this valve open except when draining tank".

B. Provide manufacturer's tags for all balancing fittings.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. Include valve-tag schedule in Operation and Maintenance Manual.

2.7 EQUIPMENT LOCATION CEILING MARKERS

A. 5/8-inch diameter celluloid covered or vinyl PSA backed stickers, suitable for ink notation on a colored face; color coded as follows:

1. Yellow: Volume Dampers
2. Blue: Isolation Valves
3. Green: Controls Devices (valves, automatic dampers, controllers)
4. Orange: Equipment (VAV boxes, fan coils, blower coils, fans, pumps, etc.)
5. Red: Fire Dampers

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE IDENTIFICATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles and flow direction arrows, complying with ASME A13.1, on each piping system. Stencils shall be crisp and neat with no overspray, drips, runs, or other imperfections visible from normal viewing distance.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 15 feet along each run.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of **15 feet** along each run.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

	Item	Color
1.	Condensate (steam)…….	Rust brown
2.	Refrigerant……...	Dark Green
3.	Heating hot water…….....	Dark Red
4.	Steam supply…….......	Orange
5.	Hot water supply & return……...	Brown
6.	Hangers, supports, base rails, etc……	Black
7.	Condensate (drain)……..	Rust Brown
8.	Refrigerant……...	Dark Green

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts.

B. Stenciled Duct Label Option: Stenciled labels, showing service, size, and flow direction as indicated above, may be provided instead of plastic-laminated duct labels, at Installer's option, for concealed ductwork or if lettering larger than 1 inch high is needed for proper identification because of distance (over ten feet) from normal location of required identification. Stencils shall be crisp and neat with no overspray, drips, runs, or other imperfections visible from normal viewing distance. Refer to Division 09 sections on painting for more information.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feetin each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

1. New construction: Provide a neat typewritten valve directory listing valve function, location and identification number. Minimum size to be 8-1/2 by 11 inches, incased within plastic laminate. Mount securely where directed.

2. Valve Numbering System: Extension of and compatible with existing valve numbering system, where valves are installed in existing building or in addition to existing building. Do not duplicate existing numbers; verify existing numbers in the field

3. Verification: Verify existing valve numbers in field and provide valve numbering avoiding duplication of existing numbers.

B. Valve Identification For New Construction:

1. Provide 1-1/2 inch diameter brass tag with brass jack chain (#16).

2. Stamp "H" and valve number for each main, riser, zone, and branch heating valve and at all other valves whose function is not readily apparent.
3. Provide a special tag at compression tank(s) shut off valve with legend as follows: "Always keep this valve open except when draining compression tank"

3.7 EQUIPMENT LOCATION CEILING MARKERS

A. Provide markers in the metal grid of lay-in tile, in metal panel ceilings, at access doors in hard ceilings, and other locations as appropriate, indicating the location of dampers, valves, controls, equipment, fire dampers, and other devices as required. Write on markers with sharply contrasting permanent ink in neat handwriting clearly identifying equipment located beyond mark with abbreviation used in valve chart, equipment schedule, etc.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Testing, Adjusting, and Balancing (TAB) Work shall be a joint effort of the Contractor and the TAB Agency, performed with the intention of leaving the systems involved in a properly functioning and balanced flow condition as designed and indicated in the Construction Documents, similar to the "Total System Balance" condition described in the AABC Standard.

1. The division of responsibility for the TAB Work is outlined below. Contractor to perform preparation and ancillary work described below, with the option of subcontracting a portion of their work to the TAB Agency, but the TAB Agency must take sole responsibility for any portion of the preparation or TAB Work defined as the TAB Agency's Work.

2. TAB Agency Work to be performed by a fully qualified independent TAB Agency as described in quality assurance below and as approved by the Architects and Engineers, to be paid for by the Contractor responsible for HVAC Work as a first tier subcontract to their work.

B. Section includes preparation for, and Testing, Adjusting, and Balancing (TAB Work) of HVAC components, equipment, and systems:

1. Contractor Preparation and Participation:

a. Place systems in satisfactory operating condition as detailed below prior to the arrival of the TAB Agency for the specified TAB Work, and notify the TAB agency, Construction Manager, and Engineer in writing when systems are ready for TAB Work.

b. Attend and actively participate in coordination and TAB meetings.

c. Keep TAB Agency apprised of construction schedule as required facilitating TAB agency job site visits prior to concealment of work. Provide overall construction schedule to TAB agency at coordination meetings and TAB meetings, update schedule regularly noting milestones and dates affecting TAB review and work schedule, and provide at minimum 7 calendar days notice prior to concealment.

d. Coordinate and provide mechanical and controls systems operation, revisions, and other ancillary work as required during TAB Work, as detailed below.

e. Make changes as required to create a testable, balanceable system, as recommended by TAB agency but only as approved by the Engineer.

2. TAB Agency Preparation:

a. Review Construction Documents and Coordination Drawings with Engineer, Construction Manager, and Contractor and assist in preparation of submittals, particularly Coordination Drawings, dampers, and balancing valves, by preparing recommendations to Contractor and Engineer on locations of balancing valves, dampers, access doors, test connections, etc., as well as any other special considerations affecting the TAB Work and/or the fabrication or engineering of the systems. Documentation of assistance shall be both by mutually agreed upon notations on the submittals / sheet metal Shop Drawings prior to submittal, and by TAB Agency's letter accompanying submittal, verifying review and TAB Agency approval of the specific submittal.

b. Visit job prior to concealment of work, repeatedly if necessary due to construction scheduling, check work, and advise the Contractor, Construction Manager, and Engineer on correctness of locations of dampers, access doors, test connections, etc., as well as any other special considerations affecting the TAB work. Advise in writing, copied to the Contractor, Construction Manager, and the Engineer within 3 days of the site visit but in any event before concealment.

C. TAB Work includes:

1. *Testing* of all mechanical components for performance, calibration, capacity, and other characteristics as outlined below and as required, demonstrating conformance with contract documents and submittals.

2. *Adjusting and Balancing* of all mechanical components of this project as described in the contract documents, achieving specified air and water flow at all terminal equipment, distribution at lowest noise levels and energy use, and achieving specified thermometer, gauge, and sensor instrument accuracy and calibration, all as outlined below.

3. Documentation, correspondence, data recording, reporting, and demonstration all as outlined below and elsewhere in the contract documents.

4. *Coordination* with other Contractors, subcontractors, Construction Manager, Owner's Representatives, and Architect / Engineer as required achieving specified TAB results.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers
C. Contractor: The entity contracted to perform the HVAC Work described in these contract documents.
D. NEBB: National Environmental Balancing Bureau.
E. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
F. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

G. TAB: Testing, adjusting, and balancing.
H. TABB: Testing, Adjusting, and Balancing Bureau.
I. TAB Agency: An entity engaged to perform TAB Work who is qualified and approved to do so as described below.

1.4 SUBMITTALS, GENERAL

A. Contractor:

1. Prior to submittal of any equipment affecting TAB Agency, review with TAB Agency and obtain commentary and approval as described in “Summary” Article. Include TAB Agency review commentary with affected submittals.

2. Immediately upon approval of other submittals, provide the TAB Agency with copies of approved submittals, including Shop Drawings of all hydronic and air systems and equipment requiring balancing.

1.5 ACTION SUBMITTALS

A. Contractor:

1. Perform no work affecting TAB prior to TAB Agency approval.

B. TAB Agency:

1. Submit TAB Agency qualifications proposal for approval.

   a. Name and contact information of proposed TAB Agency,
   b. Documentation that they meet the qualifications specified in "Quality Assurance" Article,
   c. Evidence of current TAB Agency and TAB Supervisor Certification,
   d. List of instruments to be used in testing and balancing, with current certification of all instruments’ calibration,
   e. Examples of data forms proposed for each system type showing input cells for this Project’s required data,
   f. 3 regional references for comparable recent jobs.

2. Submit Strategies and Procedures Plan: Within 30 days of Architect’s approval of TAB Agency, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

3. Submit Certified Final TAB Report.

1.6 INFORMATIONAL SUBMITTAL

A. Contractor and TAB Agency:

1. Systems Readiness Report as described more fully below.

B. TAB Agency:

1. Instrument Calibration Reports: Include the following on calibration agency letterhead:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.
   f. Test data points over range qualified – standards and measured values.

2. Contract Documents Examination Report: Within 15 days of Architect's approval of TAB Agency, submit the Contract Document Examination Report as specified in Part 3.

3. Include commentary with all Contractor submittals affecting TAB work as described above.

4. Pre-Construction Inspection and Testing Report: Prior to removal of any affected construction.

1.7 QUALITY ASSURANCE

A. TAB Agency, Employee, and TAB Work Qualifications:

1. TAB Agency: Fully certified current member of "Associated Air Balance Council" (AABC), "National Environmental Balancing Bureau" (NEBB), or "Testing, Adjusting, and Balancing Bureau" (TABB), specializing in the adjusting and balancing as specified in this Section of systems as specified and as shown on the Contract Documents, with minimum three years documented experience as a fully certified member, and three current regional references for projects of comparable scope.

2. TAB Field Supervisor: Employee of the TAB Agency and currently certified by AABC, NEBB, or TABB as a Testing, Balancing and Adjusting Supervisor.

3. TAB Technician: Employee of the TAB Agency and currently certified by AABC, NEBB, or TABB as a TAB technician.

4. All TAB Work: Performed by direct employees of the TAB Agency, who are either TAB Field Supervisors themselves, or who are TAB Technicians working under the direct supervision of a TAB Field Supervisor.

B. Conform to basic procedures and methods outlined by applicable publications in testing and balancing of air and water systems by the following organizations, and as modified by this document:

1. Associated Air Balance Council (AABC).
2. National Environmental Balancing Bureau (NEBB).
3. Testing, Adjusting, and Balancing Bureau (TABB).
4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

5. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
6. Individual manufacturer requirements and recommendations.

C. TAB Report Data Forms: Follow AABC, NEBB, TABB, or SMACNA format as modified by the data requirements of this Project, subject to submittal approval.

D. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: Instruments as described in ASHRAE 111, Section 5, "Instrumentation.", all currently certified as calibrated by a NRTL or NVLAP in accordance with Division 01 Section “Quality Requirements”.

F. Contractor: maintain qualified personnel at Project for system operation, trouble-shooting, making system changes, and performing mechanical adjustments in conjunction with TAB procedures.

1.8 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Environmental Requirements: Accomplish TAB work under appropriate outdoor temperature conditions.

C. Concealed Conditions: Before concealment of systems, verify and advise on type and location of balancing devices and test points. Make changes as required to balancing facilities.

1.9 COORDINATION AND SCHEDULING

A. Refer to Division 00 and Division 01 for overall project sequencing and scheduling requirements. All HVAC work required for, and, approvable balancing in accordance with the requirements of this section is required to be complete before Contract Substantial Completion.

1. Contractor: Assure that all HVAC work required to properly and completely test and balance the various systems, occurs in a timely fashion coordinated with the overall project schedule as required, with final readiness reported at minimum two calendar weeks prior to contract scheduled Substantial Completion Date. For HVAC Work required to be performed simultaneous with TAB Work, coordinate schedule with TAB agency and provide qualified staffing as required keeping pace with TAB agency personnel. Coordinate and report partial systems readiness to TAB agency to allow TAB work to proceed in an orderly fashion.

2. TAB Agency: Assure that all TAB Work and all subsequent reporting on same occurs in a timely fashion coordinated with the overall project schedule prior to contract scheduled Substantial Completion Date. For HVAC Work required to be performed simultaneous with TAB Work, coordinate schedule with Contractor and provide qualified staffing as required to complete TAB work and reporting within two calendar weeks of final HVAC systems readiness for TAB.

B. Tab Agency: Coordinate, schedule, and run a TAB Strategies and Procedures meeting, with Contractor, Owner, Architect, Engineer, Controls Subcontractor, and Commissioning Agent all present. Provide TAB Plan and agenda in advance, and produce and distribute meeting minutes.

C. Contractor and TAB Agency: Perform all examination and preparation work required and submit Systems Readiness Report(s) prior to beginning TAB work.

D. Contractor and TAB Agency: After submission of Systems Readiness Report, coordinate and schedule all preparation and TAB work with each other, Architect/Engineer, Construction Manager, Commissioning Agent, and Owner. Notify O/AE/CM/Cx team of all scheduled TAB work test dates and times in writing with at least seven days' advance notice for each visit.

1. Cooperate with other contractors and affected subcontractors as required to provide complete and proper testing, adjusting, and balancing of HVAC systems.

E. Accomplish TAB Work during construction period as soon as the systems are complete enough to perform TAB work. Coordinate with project phases and before Owner takes possession. TAB work and approval of at least partial pencil copy reports is required before Owner takes possession.

F. Multiple visits will be required for phased construction in cooperation with construction schedule, with multiple “pencil copy” submittals of partial TAB reports required promptly as each phase of TAB work is accomplished.

G. Perform balancing for record at final stage when all previously completed sub-systems are checked and re-balanced to design performance.

H. Contractor and TAB Agency: return to the site approximately six months after initial TAB Work is complete to perform system checkup and design condition rebalancing as defined below.

I. Contractor and TAB Agency are subject to recall to site to verify report information before acceptance of the report by the Architect.

J. Contractor: provide 2 additional copies of Shop Drawings and other submittals for all equipment and systems to be tested and balanced to TAB Agency as soon as possible but no later than 60 days prior to scheduled completion of equipment and systems installation.

K. TAB Agency:

1. Verify that Contractor has placed all systems and equipment in satisfactory operating condition as required allowing TAB Work to be properly performed.

2. Cooperate with Contractor and affected subcontractors as required to provide complete and proper testing, adjusting, and balancing of air and water systems.

3. Visit Project prior to concealment of Work and note location of dampers, test connections, and similar items. Record this information, transmit to Contractor, and incorporate on Record Drawings.

4. Coordinate timing of six month system check and design condition TAB Work with weather, Contractor, and Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. TAB Agency: Provide tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers, tachometers, ultrasonic or other non-intrusive flowmeters, and all other instrumentation required to perform specified TAB work. Accurately calibrate all instruments.

1. Make instruments available to Architect to facilitate spot checks during testing and back-checking.
2. Provide additional balancing devices as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. By TAB Agency:

1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

2. Visit Site and examine existing systems before construction and new / re-worked systems prior to concealment of construction to check on and advise regarding location of installed balancing devices, such as test ports, gage cocks, thermometer wells, thermometers and gages, flow-control devices, balancing valves and fittings, volume dampers, test connections, etc. Verify that locations of these balancing devices are accessible. TAB Agency shall advise Contractor and Architect of TAB Agency findings by letter.

3. Examine the submittals for HVAC systems and equipment. Verify that proposed equipment can be balanced as specified and as required. Provide commentary on all submittals advising where additional balancing devices are needed or configuration adjustment is desired to facilitate TAB work.

4. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

5. Examine test reports specified in individual system and equipment Sections.

6. Examine manufacturer's equipment performance data including pump and fan curves.

   a. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

B. By Contractor:

1. Examine systems and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections has been performed, and all TAB preparation as described in "Preparation" Article is complete.

3.2 PREPARATION

A. TAB Agency:

1. Prepare a TAB plan that includes site specific strategies and step-by-step procedures with this project's equipment identified.

B. Contractor: Before TAB work commences on any portion of the system, and before new system startup, verify that systems are complete and in proper operating condition. Ensure the following:

1. Equipment is operable, in a safe and normal condition, and is of the size and capacity specified in the Contract Documents, bearings are greased, belts are aligned and properly tight, and equipment with functioning controls is ready for operation. Required modifications to systems shall be made in advance of the TAB Agency's arrival for that portion of the work.

2. Provide proper equipment start-up as specified, complete with manufacturer's filled out standard published start-up forms.

3. Temperature control systems are operable to the extent required for that portion of the TAB Work. Control valves must at least be installed complete and hand operable. Automatic dampers must be operable and under control. Safety interlocks and controls on HVAC equipment must be properly functional.

4. All motors, pumps, and fans have correct rotation.

5. Permanent electrical-power wiring is complete, and proper thermal overload protection is in place for all electrical equipment.

6. All ductwork, air handlers, grilles, registers, and diffusers are installed, complete, and cleaned of dust and debris.

7. All piping, terminal radiation, boilers, chillers, heat exchangers, pumps, valves, required pressure taps, and hydronic specialties are correctly installed, complete, operational, and clean.

8. All ductwork, diffusers and registers have dampers where specified, and all hydronic systems have balancing and isolation valves where specified.

9. Duct system leakage has been tested where required and minimized.

10. Hydronic systems are flushed, vented, cleaned, leak free, and filled with specified heat transfer fluid.

11. Hydronic expansion tank has been pre-charged to the proper pressure and systems filled to proper cold fill pressure.

12. System pump suction piping is properly vented to ensure absence of entrained air.

13. All manually set dampers (fire, fire/smoke, register, grille, diffuser, and manual volume dampers) operate smoothly and are adjusted open. All automatic dampers have actuators and required linkages installed and rough adjusted.

14. All hydronic systems valves are installed with proper direction of flow and operate smoothly, balancing valves are adjusted open, two-way control valves are open, three-way valves are properly installed for their intended function of diverting or mixing fluid flows, and service valves are open or closed as required for normal flow.

15. Make preliminary adjustments to airflow patterns of all registers, grilles, and diffusers to obtain uniform space temperatures and air movement free from objectionable drafts and noise.

16. Clean new final design filters are installed everywhere called for.

17. Hydronic strainers are clean and any temporary screens are replaced with permanent screens. Sidestream filters have clean new filter bag installed and valves are closed.

18. Coil fins are clean and straight.

19. Access doors in ducts are closed and duct end caps are in place.

20. Access doors necessary to reach duct volume dampers, balancing valves, and measuring stations are installed in accessible locations and are operable.

21. As-built conditions are accurately recorded on working as-built drawings, including locations of all access points, manual and automatic dampers, isolation, balancing, and control valves, fittings, and all other items affecting TAB work. Provide copies of these annotated as-built drawings for TAB agency's use during TAB work.

C. Contractor:

1. Prepare and submit Systems Readiness Reports to Engineer, Commissioning Agent, and TAB Agency, with itemized checklists of the above items as appropriate for the equipment to receive TAB Work, with a column for Contractor indicated status and another with room for TAB Agency commentary, itemizing any remaining deficiencies discovered and confirming all systems preparation and examination has been properly performed.

    a. Include itemized list of all examination and preparation procedures outlined above and as otherwise required by TAB Agency's procedures, with initialed dated verification of each item by authorized responsible party.

    b. Promptly report abnormal conditions in mechanical systems or conditions that prevent system balance. If, for design reasons, system cannot be properly balanced, report as soon as observed.

2. Report any defects or deficiencies observed during performance of TAB procedures.

D. TAB Agency:

1. Review, edit, and submit annotated Contractors Systems Readiness Reports to Contractor, Engineer, and Commissioning Agent, with itemized TAB Agency concurrence or commentary, itemizing deficiencies discovered and confirming all systems preparation and examination has been properly performed, with initialed dated verification of each item by authorized responsible party.

    a. Report abnormal conditions in mechanical systems or conditions that prevent system balance within 24 hours of discovery. If, for design reasons, system cannot be properly balanced, report as soon as observed.

2. Report any defects or deficiencies observed during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values. Include updates in partial TAB report submittals. Adjust as-built drawings as required to accurately reflect deviations from draft as-built set.

3. Promptly report abnormal conditions in mechanical systems or conditions that prevent system balance. If, for design reasons, system cannot be properly balanced, report as soon as observed.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. In the following TAB procedures portions of Part 3 Execution of this document, the procedures are deemed to be TAB Agency work unless specifically identified as Contractor work.

B. Contractor required assistance and Ancillary Work during TAB Agency Work includes the following general work categories and notes on Contractor Work requirements in subsequent specific procedure descriptions:

1. Maintain mechanically qualified personnel at Site to perform necessary mechanical modifications and adjustments in conjunction with TAB procedures.

2. Operate systems.

3. Provide trouble-shooting.

4. Change and re-align pulleys, sheaves, belts, etc., as required to meet system performance requirements. Provide machined steel or cast iron sheaves of quality equal to OEM equipment, and cogged premium raw edge belts. Properly adjust belt tension. Maintain specified drive safety factor – do not reduce the size of the smaller sheave /pulley without explicit written approval of first manufacturer then engineer.

5. Cut insulation, pipes, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. Properly plug all holes. Provide new insulation that matches removed materials, finished in accordance with Division 23 Section "HVAC Insulation."

6. Change air filters as required.

7. Adjust automatic damper linkages so they all operate smoothly and close tightly.

8. Perform necessary controls operations required for TAB procedures.

9. Re-adjust / make final adjustments to registers, grilles, and diffusers in cooperation with Owner and TAB Agency as required to obtain uniform space temperatures and air movement free from objectionable drafts and noise. As this affects system pressure drops, this must be completed before final airflow balancing.

10. Make any required additions or changes in types, locations, etc., of balancing equipment.

11. Provide other mechanical adjustments as required in conjunction with TAB procedures.

12. Leave system in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes and securing cover plates, restoring thermostats to specified settings, restoring systems to automatic operation as required, replacing ceiling tiles, plugging access ports and repairing insulation, cleaning, etc...

C. Tab Agency: Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.

1. Provide all testing and Balancing as required by the specific procedures outlined below and as required to provide the final test report as described below.

2. Mark equipment and balancing devices, valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES: AIR SYSTEMS TESTING, ADJUSTING, AND BALANCING

A. Visit Site prior to concealment of construction to check and advise regarding location of dampers, test connections, etc. TAB Agency shall advise Contractor and Architect of TAB Agency findings by letter.

B. Review sheet metal shop drawings and mark locations of all required balancing dampers before duct fabrication.

C. Re-check fan belt pulley alignment under properly tensioned condition, and report final tolerances and tension achieved. Direct re-alignment as required to achieve stated tolerances.

D. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct in such a manner that local flow dynamics have a negligible effect on the measurements. Use multiple, bidirectional, traverses if flow measurements cannot be made in a section with at least 8 diameters straight duct upstream and 4 diameters of straight duct downstream from the measuring station. Mark all traverse locations on plans in report.

E. After adjustments, take measurements to verify balance has not been disrupted. Verify that disruptions in balance have been corrected.

F. Permanently mark valve, damper, and other adjustment device settings at devices to simplify restoration of settings. Record settings and include in report. Set and lock memory stops.

G. Procedures:

1. Verify that all systems are complete and operable as scheduled.

2. Verify that registers, grilles, and diffusers are adjusted to obtain uniform space temperatures and air movement free from objectionable drafts and noise. Cooperate with Owner and Contractor and reach agreement on air distribution pattern before proceeding.

3. Provide temporary filter media as follows: with the system fully operational, all dampers open, and the fan running at the scheduled RPM, check submittal values for new, midlife, and final/clogged filter pressure drops, check and record air pressure drop across the new clean final design filters, and provide temporary media to approximate midlife pressure drop across the filters for use during balancing. Record and report both pressure drop values at the final design flowrates. Adjust filter differential pressure switches to trip at correct final/clogged filter pressure drop in cooperation with Energy Management and Control System manufacturer's representative.

4. With the system fully operational, all dampers open, and the fan running at the approved submittal RPM, measure the airflow through all terminal units as well as the total system volume, without making any adjustments, and formulate a plan for preliminary adjustments of dampers and fan speed. Terminal units shall be defined to include all diffusers, registers, grilles, duct entries, louvers, hoods, etc.; i.e., wherever air enters or leaves ductwork whether indoors or outdoors. Record and report all initial values.

5. In cooperation with Energy Management and Control System manufacturer's representative, make mechanical adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Adjust and set the extreme operating conditions of these dampers and check completed damper control operations for proper calibration, reporting to control installers conflicts with those requiring adjustment. Test leakage of closed dampers. Adjust and set intermediate positions of outside air and return air dampers as required to achieve design outside airflow requirements defined in the sequence of operations, and / or calibrate outside air flow meters at this point. Balance variable volume systems at maximum air flow rate with full cooling and at minimum air flow rate with full heating

6. Adjust terminal units to the proportionally correct cfm, not necessarily the design cfm.

    a. If all the dampers in a branch line's terminal units must be adjusted to limit cfm, then use the branch line volume damper to limit the pressure drop across the terminal units in that branch so that at least one terminal unit's damper remains wide open but still has the correct flow. Adjust all branch ducts to proper proportional cfm in this way, leaving the volume dampers in the flow limiting branches wide open.

    b. Provide branch duct volume control by duct internal devices such as dampers and splitters only to the extent that the most open damper or splitter remains wide open and adjustments do not create objectionable air motion or sound levels. Under no circumstances shall total air system volume be throttled back to design flow through the partial closing of all dampers and splitters.

    c. Record and report all initial adjustment positions and proportional flowrates achieved.

7. Vary total air system flowrate by adjustment of fan speeds. Provide drive changes required.

    a. For variable frequency drive fans, perform the following procedure:

    b. With the VSD set to bypass mode or set at 60 Hz, adjust the fan belt drive system (if applicable) as described above to achieve the design system cfm, with bypass dampers etc. closed or otherwise in the maximum resistance position.

    c. Adjust the VSD to the maximum non- overloading frequency for the system, and measure and report the flowrate at this frequency

    d. If other specific air flow rates are required due to the sequence of operations as reported on the drawings or in Section 23 09 00 – Instrumentation and Control for HVAC, coordinate with these requirements and determine the required frequency - flow relationships

8. Verify that all terminal units are at the design cfm to within the balancing tolerance, and if not, repeat steps f. and g. above until design conditions are satisfied.

9. Test and record final motor, drive, air moving equipment, exhaust fan, damper, and terminal unit information at this point.

10. After all air flow rates are tested, adjusted, and balanced, test the performance of all air to air energy recovery equipment. Test the performance of air to air energy recovery equipment only when the outside air and inside air temperatures are close enough to summer or winter design conditions to verify performance. Test under either summer or winter conditions; if design conditions cannot be met during initial TAB work due to timing, provide energy recovery core testing under true design conditions at the six month system check. Include all data as specified above in reports.

11. Test and record air heating and cooling coil information after this point, as follows:

    a. Perform this step in conjunction with hydronic system balancing and after cooling and heating systems are operational.

    b. Set hydronic control valve to fully open at design flow and temperature as described below. Allow cooling coils to become fully wet with condensation. Test temperatures outside of the line of sight to the coil.

    c. Test and adjust coil performance for all data indicated to be on report test sheets.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at maximum airflow through the cooling coil.
B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.

2. Check liquid level in expansion tank.

3. Check makeup water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation, and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.
B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
D. Check settings and operation of each safety valve. Record settings.
E. Verify the operation of each steam trap.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the automatic and manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.12 PROCEDURE FOR MISCELLANEOUS DEVICE TESTING

A. Test and adjust all devices on project as required to correctly report the data listed below under paragraph on final report.

3.13 TOLERANCES

A. Adjust system totals to the sum of the connected load (plus leakage for air systems) rather than the scheduled pump or fan capacity.

B. Adjust air handling systems as follows:

1. Main ducts (ie. each fan system) to within minus 5 percent and plus 10 percent of the design values.
2. Outside air flow tolerance shall be at minimum that scheduled, with a tolerance of minus 0 percent and plus 10 percent.
3. Branch ducts and terminal units to within plus or minus10 percent of the design flow.
4. A total maximum variation of 10 percent between terminal units designated as “typical of (#)”.

C. Adjust hydronic systems as follows:

1. Each pump to within 5 percent of the design flow values.
2. Branch lines and radiation to within 10 percent of the design flow values
3. A total maximum variation of 10 percent between terminal units designated as “typical of (#)”

3.14 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB contractor.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Settings for supply-air, static-pressure controller.
    f. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air Moving Equipment (FCU, CUH, RTU, or UV):

1. Location

2. Manufacturer

3. Model

4. Air flow, specified and actual

5. Return air flow, specified and actual

6. Outside air flow, specified and actual

7. Total static pressure (total external), specified and actual

8. Labeled diagram showing pressure drop across each internal component including dampers, filters, coils, diffusers, and blowers. Provide multiple readings for complex systems with multiple internal dampers affecting system pressure drops, under all specified modes of operation.

9. Inlet pressure

10. Discharge pressure

11. Applicable data as specified elsewhere including coil, motor, damper, and drive data.

12. Fan RPM (for VSD driven fans, under various design conditions including at least full heating, 100% OA economizer, and full cooling loads)

F. Exhaust Fan Data (PRE, PWE, EF, F):

1. Location
2. Manufacturer
3. Model
4. Air flow, specified and actual
5. Total static pressure (total external), specified and actual
6. Inlet pressure
7. Discharge pressure
8. Fan motor and drive data
9. Fan RPM(for VSD driven fans, under various design conditions including at least full heating, 100% OA economizer, and full cooling loads).

G. Apparatus-Coil Test Reports:

1. Coil Data:

   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

   a. Air flow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.

f. Entering-air, wet- and dry-bulb temperatures in deg F .
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

I. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

    a. Total air flow rate in cfm.
    b. Entering-air temperature in deg F.
    c. Leaving-air temperature in deg F.
    d. Air temperature differential in deg F.
    e. Entering-air static pressure in inches wg .
    f. Leaving-air static pressure in inches wg.
    g. Air static-pressure differential in inches wg.
    h. Low-fire fuel input in Btu/h.
    i. High-fire fuel input in Btu/h.
    j. Manifold pressure in psig.
    k. High-temperature-limit setting in deg F.
    l. Operating set point in Btu/h.
    m. Motor voltage at each connection.
    n. Motor amperage for each phase.
    o. Heating value of fuel in Btu/h.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg .
    e. Duct size in inches.
    f. Duct area in sq. ft..
    g. Indicated air flow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual air flow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.
    b. Air velocity in fpm.
    c. Preliminary air flow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final air flow rate in cfm .
    f. Final velocity in fpm.
    g. Space temperature in deg F.

L. Electric Motors:

1. Manufacturer
2. HP/BHP
3. Phase, voltage, amperage (nameplate, actual, and no load)
4. RPM
5. Service factor
6. Starter size, rating, heater elements

M. Automatic Air Dampers (AAD, TBAAD, or internal to air moving equipment):

1. Location

2. Manufacturer

3. Model

4. Airflow, specified and actual.

5. Check closed position leakage and report.

6. Damper and/or actuator position at all required positions, along with associated controls signal required to achieve position. Coordinate required positions of return air and outside air ventilation control dampers with positions required by required ventilation rates. Refer to SECTION 23 09 00 – INSTRUMENTATION AND CONTROLS FOR HVAC, and coordinate damper position adjustment with temperature controls and Owner's required occupancy schedule.

7. Total static pressure drop at all required positions.

N. Manual Air Volume Dampers (VD, or shown with no text as: ⊺):

1. Location.
2. Report final damper position as angular deviation of blades from axial, with 0° being fully open and 90° being closed. Mark this position on duct at damper also.
3. Total static pressure drop across damper in as balanced condition.

O. Air Distribution Test Sheet (registers, grilles, and diffusers):

1. Air terminal number
2. Room number/location

3. Space Temperature
4. Terminal type
5. Terminal size
6. Area factor
7. Design velocity
8. Design air flow
9. Test (initial, adjusted, and final) velocities
10. Test (initial, adjusted, and final) air flows
11. Percent of design air flow

P. Roof Top Hoods, Goosenecks:

1. Air terminal number / drawing designation
2. Room number/location
3. Terminal type
4. Terminal size
5. Free Area
6. Design velocity
7. Test (final) velocity
8. Design air flow
9. Test (final) air flow
10. Percent of design air flow
11. Design Pressure drop
12. Test (final) pressure drop

Q. Balancing Valves:

1. Identification/station
2. Location
3. Size
4. Manufacturer
5. Model
6. Design flow rate
7. Design pressure drop
8. Actual/final pressure drop
9. Actual/final flow rate
10. Station calibrated setting

R. Hydronic Control Valves Reports:

1. Location
2. Manufacturer
3. Model
4. Flowrate, specified and actual.
5. Pressure drop at full flow condition.

S. Gauges and Thermometers Reports:

1. Identification/number
2. Location
3. Service

4. Manufacturer
5. Test all gauges and thermometers for mid range accuracy. Adjust thermometers where applicable; adjust all gauges for best 0 and/or midrange accuracy.
6. Temperature, test reading and actual
7. Pressure, test reading and actual

T. Controls Sensors Reports:

1. Coordinate work with Energy Management and Control System.

2. Test all controls system temperature, pressure, air monitoring (CO_2, CO, combustible gasses, humidity, etc.), and electrical current analog sensors for mid normal operating range accuracy. Adjust where applicable.

3. Test all controls system temperature, pressure, air monitoring (CO_2, CO, combustible gasses, humidity, etc.), and electrical current digital (on/off) sensors/switches for trip point. Adjust where applicable.

4. Verify that locations shown on Operators Work Station are schematically correct.

5. Identification/number

6. Location

7. Service

8. Manufacturer

9. Temperature, test reading and actual

10. Pressure, test reading and actual

11. **A**ir composition, parts per million, test reading and actual. Test and adjust at normal ambient and alarm conditions.

U. Instrument Calibration Reports:

1. Report Data:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

   a. Measure water flow of each device.
   b. Verify that balancing devices are marked with final balance position.
   c. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection by TAB Agency is complete and documentation verifies that testing and balancing are complete and accurately documented in the report, request that a final inspection be made, giving at minimum 7 calendar days' notice. Deliver copies of Draft Final Report to Engineer and Commissioning Authority with final inspection request.

   a. Engineer may elect to postpone final inspection upon delivery of written notice to TAB Agency that significant portions of the required TAB results are missing from draft report. If inspection is postponed, TAB Agency shall promptly return to site and provide missing TAB Work, then submit a revised draft and request the Final Inspection again.

2. The TAB Agency and Contractor's qualified technicians are to provide access, tools, and measurements during the inspection in the presence of the TAB Agency Supervisor and the Commissioning Authority.

3. Commissioning Authority will randomly select measurements, documented in the report or as required by contract, to be rechecked. Rechecking will be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED." If recheck calls for a measurement that is required but cannot be found in the draft report, the missing measurement will be noted as "MISSING".

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB Work will be considered defective and rejected. If the number of "MISSING" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB Work will be considered defective and rejected.

C. If TAB Work is considered defective and rejected, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. Pay all costs associated with second inspection including Commissioning Authority's reasonable additional fees.

2. If the second final inspection also fails, Owner may require additional inspection similar to second inspection or may contract the services of another TAB agency to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB Agency's final payment.

D. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

A. Re-check and adjust systems approximately 6 months after final acceptance and submit report:

1. Measure the total flow rate of each of the systems originally covered by this section.

2. For each of the systems that no longer operate at design flow measure the flow at each of the terminals of that system.

3. Measure the flow at any terminals included in the original balancing, reported by the Owner or Architect to have continued or new problems.

4. Adjust system changes back to the design values if possible, and submit reports in writing to the Architect, Contractor, and Owner, noting any changes and/or complaints, and offering an interpretation of the cause and significance of the problems.

5. If the design air temperature criteria as specified cannot be satisfied upon initial balancing, perform this six month stability check at a time when it can be, and repeat water system balancing and chiller / heat exchanger performance testing using air temperature at the design conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 – HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and all Division 01 Sections, apply to this Section.

1.2 SUMMARY

A. Section includes materials and installation requirements for mechanical component insulation and related accessories.

1. Insulation Materials:

a. Calcium silicate.
b. Cellular glass.
c. Flexible elastomeric.
d. Mineral fiber.
e. Phenolic.
f. Polyisocyanurate.
g. Polyolefin.
h. Polystyrene.
i. Fire rated insulation systems

2. Insulation Accessories:

a. Insulating cements.
b. Adhesives.
c. Mastics.
d. Lagging adhesives.
e. Sealants.
f. Factory-applied jackets.
g. Field-applied fabric-reinforcing mesh.
h. Field-applied cloths.
i. Field-applied jackets.
j. Tapes.
k. Securements.
l. Corner angles.
m. Insulation protection systems

1.3 DEFINITIONS

A. “Concealed”: Work within or behind various construction elements, or in crawl spaces or trenches, that is not exposed to view when Project has been completed. (Areas above ceilings, including above Auditorium or Large Group Instruction partially open “cloud” ceilings and chases are considered a concealed location.)

B. “Exposed”: Anything exposed to view when project has been completed.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 – Submittal Procedures and as modified below.

B. Provide all submittals required by this Section concurrently.

C. Product Data

1. Submit complete manufacturer’s product information for each type of insulation and accessory specified in this section demonstrating compliance with specified requirements and including:

   a. Thermal and vapor transmission performance.
   b. Flame spread / smoke developed data.
   c. Manufacturer’s recommended installation methods.

D. Submit insulation schedule indicating each required service with type of insulation, thickness and R value, covering method, finishes, and any applicable notes.

E. Quality Control Submittals

1. Qualifications Certification: Submit written certification of installers signed by applicable certification agency and/or manufacturer (where applicable) indicating compliance with “Installer Qualifications” requirements specified below in “Quality Assurance” article.

2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including Owner contact information for each project, demonstrating compliance with applicable “Qualifications” requirements specified below in “Quality Assurance” article.

3. Provide mock-ups for review and approval as described below.

F. Contract Closeout Submittals: Comply with requirements of DIVISION 1 sections on closeout, including submission of maintenance instructions as item in "Operating and Maintenance Data" manual described there.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Provide insulation system installation by qualified Installers who are trained in installation of each proposed insulation material and product with at least one of the following qualifications:

1. Have successfully completed a mechanical insulation apprenticeship program by the Department of Labor, Bureau of Apprenticeship and Training,
2. Have successfully completed an ASHRAE / NIA 8 hour Mechanical Insulation Training course or equal, or

3. Have five years documented experience as a mechanical insulation specialist with references attesting to successful completion of at least three comparable projects.

B. Condensation Resistance: Provide insulation and vapor barrier systems complete as required to eliminate condensation under any normal operating conditions from surfaces of all cooling equipment and components provided or modified as a part of this contract Work, unless those surfaces are designed to remove moisture by condensation from process air, and to contain and drain the condensate.

C. Mockups: Before installing insulation in general, install example mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Install mockups in the location indicated or, if not indicated, in general in conveniently accessed locations in mechanical spaces where insulation will remain exposed for continued review. Coordinate specific locations with CM and Architect. Use materials indicated for the completed Work.

1. Ductwork Mockups:

   a. One 10-foot section each of rectangular and round straight duct.
   b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
   c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
   d. One rectangular to round transition fitting.
   e. Four support hangers for round and rectangular ductwork.
   f. One roof deck penetration at RTU or PRE.
   g. Exterior duct insulation examples.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, jackets, and all other associated components. Provide labeling of all components as required to allow identification by observers.

3. Notify Architect seven days in advance of dates and times when mockups will be constructed.

4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

7. Remove labeling and cutaway sections of mockups when directed and complete insulation per specifications and as required integrating with balance of job.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Components."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.8 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. For convenience, details and specifications have been based on products by the following manufacturers:

1. Armstrong; Lancaster, Pennsylvania
2. Benjamin Foster
3. CertainTeed; Valley Forge, Pennsylvania
4. Fit Tight Covers, Inc.
5. Johns Manville; Defiance, Ohio
6. Kingspan Tarec
7. Knauf; North Carolina
8. No Sweat Valve Wraps, Inc.
9. Owens-Corning; Toledo, Ohio
10. Polyguard Products Inc., Ennis, Texas
11. Thermaxx, LLC.
12. Or Approved Equal.

2.2 MATERIALS

A. Pipe and Fitting Insulation: Provide pipe insulation in compliance with ASTM C 585 Dimensional Standards.

1. Insulation Thickness:

a. Pipe and fitting insulation thicknesses specified assume an insulation conductivity (k) value of 0.27 btu•in/hr•ft2•ºF. For pipe and fitting insulation with conductivity other than 0.27 btu•in/hr•ft2•ºF, insulation must be thicker for higher conductivity and may be thinner for lower conductivity as required to achieve same or higher R value. Adjust insulation thickness from that specified in accordance with the following formula:

T = r[(1+t/r)K/k-1] where:

1) T = Adjusted insulation thickness, inches
2) r = Actual pipe outside radius, inches.
3) t = Insulation thickness specified, inches.
4) K = actual insulation conductivity, btu•in/hr•ft2•ºF.
5) k = specified conductivity, 0.27 btu•in/hr•ft2•ºF.

b. Hydronic Piping for Heating:

1) Pipe sizes ½ inch through 1-¼ inches ..... 1-1/2 inch
2) Pipe sizes 1-½ inches and larger ..... 2 inches

c. Steam Heating Piping:

1) Pipe sizes ½ inch through 3-½ inches ..... 2-1/2 inch
2) Pipe sizes 4 inches and larger ..... 3 inches

d. AC Condensate Drain Piping

1) All pipe sizes ..... ½ inch

e. Refrigerant Suction Piping:

1) All pipe sizes ..... 1 inch

f. Flexible Connections:

1) Pipe sizes ½ inch through 1-½ inches ..... 1/2 inch
2) Pipe sizes 2 inches and larger ..... 1 inch

g. Runout piping in restricted spaces where it is not possible to provide the specified thickness may use reduced thickness insulation as required by space restriction.

2. Interior Above Grade Hydronic and Steam Piping Insulation:

a. ASTM C547, cylindrically molded preformed rigid half pipe shell forms, factory one-piece “hinged” construction.

1) Rigid pipe or tube insulation may be of mineral wool, fiberglass, closed cell glass, formed polyisocyanurate, formed phenolic, or extruded polystyrene (chilled service only).

2) Thermal Conductivity ("k"): Measured in accordance with ASTM C 335. For k values greater than 0.27, include calculations and compliant increased thickness proposed. For k values equal or less than 0.27, provide specified insulation thickness or calculations justifying thinner insulation.

3) Jacket: All Purpose (AP) vapor barrier jacket with:

a) White kraft paper outer surface bonded to aluminum foil, reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.

b) Self sealing pressure sensitive lap.

c) Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.

d) Puncture resistance: ASTM D781, 85 scale units minimum

e) Burst resistance: ASTM D774, 100psi minimum.

f) Similar to "150TL facing" as used in "AP T Plus Jacket" and tape by Johns Manville, or equal.

3. Refrigerant Piping, Flexible Connections Insulation: fire-resistant, closed cell flexible (elastomeric) foam plastic, similar to Armacell Armaflex with manufacturer's white painted mastic protective finish. For exterior refrigerant piping, provide exterior pipe insulation protective jacket specified below.

4. Make-up water and Condensate Drain Lines: insulation material similar to rigid pipe or refrigerant piping insulation specified above.

5. Fitting and Valve Insulation: Precut fiberglass blanket to match thickness, appearance and insulation value of adjacent pipe insulation; similar to "Hi Lo Temp Fiber Glass Insulation Insert" by Johns Manville, with fitted protective jacket specified for the installation.

B. Pipe and Fitting Protective Jackets:

1. Intended for permanent installation on non-serviceable components only.

2. Interior Pipe and Fitting Insulation Protective Jacket:

a. Plastic: High-impact, UV resistant polyvinyl chloride, white, paintable, covering designed to fit over AP jacketed insulated piping systems, molded to fit various sizes of fittings and piping as required; similar to "Zeston 2000 or Zeston 300 PVC Jacketing" by Johns Manville.

1) 20 mil thickness: Fittings and valves in interior applications eight feet above finished floor and higher.
2) 30 mil thickness: Fittings, valves, and straight pipe in interior applications lower than eight feet above finished floor.

b. Aluminum: Circumferentially corrugated 20mil thick or embossed 24 mil thick, with approved moisture barrier, with matching preformed fitting covers by same manufacturer. Similar to Corrolon by Childers.

C. Valve Covers, Serviceable Hydronic Component Insulation Jackets:

1. 2" nominal size and smaller Strainers, Triple Duty, Autoflow Control, Manual Balancing, Check, Combination, and Control Valves, and other similar piping components needing periodic service, maintenance or adjustment - provide easily removable insulation jacket requiring no special tools for installation or removal / replacement:

a. Factory fabricated removable and reusable cover similar to products by No Sweat Valve Wraps, Inc., or approved equal.

b. Size so outer jacket overlaps adjoining sections of pipe insulation.

c. Flame and smoke spread 25/50 per ASTM E-84 or less.

d. Maximum k- factor .26 or matching surrounding insulation, using fiberglass blanket.

e. Outer jacket made of material equal to DuPont Tychem® QC (polyethylene coated Tyvek) , overlapping and completely covering the insulation with seams joined by integral elastic banding and tabs made from hook and loop fasteners (Velcro).

f. Butt ends and stem penetrations have sewn-in-place elastic. On cooling service, provide PSA backed closed cell foam gasket material adhered to stem penetration or surrounding insulation jacket between substrate and elastic jacket closure, as required insuring a complete vapor seal.

D. Duct Insulation

1. Provide insulation thickness on ducts, plenums, and equipment equal to height of flanges, but not less than thickness required to achieve duct insulation R values specified herein:

a. R=6 deg. F-sq. ft.-h/Btu-in:

1) All interior HVAC duct where insulation is required, unless otherwise noted elsewhere.

b. R=12 deg. F-sq. ft.-h/Btu-in

1) Interior outside air intake duct

c. R=12 deg. F-sq. ft.-h/Btu-in:

1) Exterior Duct with no transverse dimension above 48 inches (R=10 minimum, not average)

d. R=20 deg. F-sq. ft.-h/Btu-in:

1) Exterior Duct with any transverse dimension above 48 inches (R=20 minimum, not average)

e. Insulate to Special R values, as specifically noted elsewhere:

1) Boiler breeching, high temperature duct, fire rated duct

2. Rigid Board: 3 PCF minimum density glass fiber board (6PCF when exposed in mechanical or utility spaces) or phenolic, with factory-applied AP vapor barrier; similar to "800 series Spin-Glas" and "AP" facing by Johns Manville, or Kingspan KoolDuct.

3. Semi-Flexible: 2.5 PCF minimum density continuous glass fiber oriented strand sheets, with factory-applied AP vapor barrier. Strand orientation such that material has comparable rigidity to board type insulation above in one direction and comparable compressive strength, but is flexible enough in the other direction to wrap curved surfaces at a factory recommended minimum bend radius of 3T where T is the material thickness. Similar to "CrimpWrap" by CertainTeed.

4. Flexible: Glass fiber blanket, 3/4 PCF minimum density, with factory-applied, flame-resistant, FSK jacket; all joints taped; similar to Owens Corning "Fiberglas All Service Duct Wrap".

5. Acoustical / Thermal Duct Lining:

a. Increase sheet metal size as required to provide free area shown on drawings

b. 1-inch thick minimum for sound lining or as otherwise noted. Where used together with external duct insulation, the combined R value must be at least that specified for the service. Where used in lieu of other thermal insulation, provide with rated R-value at least that specified for duct application.

c. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature (R value equals 4.2 per inch minimum).

d. Surface exposed to air stream and factory edges bonded then coated with a fire, bacterial, fungal and abrasion resistant coating; rated for velocities up to 4000 fpm.

e. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723 or ASTM E 84 as applicable, meets requirements of NFPA 90A; certified by an NRTL.

f. Materials:

1) Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

g. Liner Adhesive: As recommended by insulation manufacturer, low VOC, complying with NFPA 90A, NFPA 90B, and with ASTM C 916 as applicable.

6. Exterior Duct Insulation: Rigid closed-cell extruded polystyrene or phenolic board with integral high density skin, foil or poly faced as recommended by insulation covering manufacturer, tongue and groove along long edges; complying with and exceeding requirements of ASTM C 578 for Type IV insulation, with the following properties:

a. Density: 1.6 pcf minimum.
b. Thermal resistance (R) at 75 deg. for 1-inch thickness: 5 nominal.
c. Compressive resistance at 10 percent deformation or yield: 25.0 psi minimum.
d. Tapered thickness as required to provide ¼" to the foot slope for water shedding.
e. Flame spread (ASTM E84): less than 75.
f. Fuel contributed (ASTM E 84): less than 100.
g. UL listed.

E. Ductwork Insulation Protective Jackets:

1. All Purpose (AP) Vapor Barrier for Duct Insulation: White kraft paper outer surface bonded to aluminum foil and reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.

a. Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.
b. Puncture resistance: ASTM D781, 85 scale units minimum
c. Burst resistance: ASTM D774, 100psi minimum.
d. Similar to "150TL facing" as used in "AP T Plus Jacket" and tape by Johns Manville, or equal.

2. Exterior Duct Insulation Covering:

a. Modified bituminous, aluminum skinned, peal and stick membrane, similar to Polyguard "Alumaguard 60", with the following properties:

1) Minimum 60 mils thick
2) Permeance less than 0.01 Perms
3) Puncture resistance per ASTM E154 >40lbs.
4) Overlap bond peal adhesion per ASTM D1000 never less than 11lb/in.
5) UV stabilized.
6) Self healing when punctured.

b. EPDM membrane as specified in Division 07 section 07 53 23 – EPDM Roofing.

F. Mechanical Equipment Insulation:

1. Thickness of insulation:

a. Air Conditioning Service Diffusers: ½ inch (R=2 minimum)

2. Air Conditioning Service Diffuser Insulation:

a. Insulation: fire-resistant, closed cell flexible (elastomeric) foam plastic; similar to Armstrong "AP Armaflex". Provide sheet stock with either PSA backing or manufacturer's recommended adhesive – seal all joints with same adhesive.

G. Insulation Accessories:

1. Mechanical Pin Fasteners: Provide welded or adhered pins of length based on manufacturer's recommendations for insulation density and thickness, securely holding insulation with insulation manufacturer's recommended compression. Mechanical Pin Fastener types include:

a. Stud style welded pins minimum 12 gauge diameter with matching push-on washers. Welded on with capacitor discharge type pin welder with no burn through or undercutting. Welded on prior to insulation application allowing for inspection prior to insulating.

b. Cup head style welded minimum 12 gauge diameter with integral washers. Welded on with capacitor discharge type pin welder with no burn through or undercutting. Welded on after insulation application dis-allowing inspection of pin welds without insulation removal. Not permitted for any Class A or tighter duct, not permitted for any fire rated duct insulation application.

c. Adhered style with perforated metal back plate (minimum 4 square inches surface area) welded to 12 gauge pins with matching push washers, bonded with full coverage of manufacturer's recommended adhesive. Not permitted for any fire rated duct insulation application.

d. Not permitted: PSA backed "peal and stick" pins, sheet metal fastening screws, or any other penetration of duct by fasteners.

2. Insulation Securement Bands: For larger cylindrical surfaces and fire rated duct insulation, tension securement bands may be used to supplement or replace mechanical pin fasteners. Provide bands of material compatible with insulation and system being insulated, minimum ½ inch wide and as required to avoid compressing insulation at required securement tension (3/4 inch minimum for diameters over 36 inches), 24 gage thick or thicker. End buckles of similar material. Wrapping or securing with wires not permitted.

3. Insulation Covering Canvas: 8 oz., 100 percent cotton, with flame spread 10 and smoke developed 0 ratings; similar to "Thermocanvas" by Fattal, Chicago, Illinois.

4. Insulation Tapes: Provide insulation manufacturers' recommended and matching tapes, matching characteristics of exterior jacket of insulation, in widths as required and as specified below to seal all gaps and reinforce vulnerable areas in vapor barrier. Provide tapes with peel off protective coating covering high performance acrylic adhesive unless manufacturer documents superior performance of alternative recommendation.

5. Insulation Adhesives and Mastics: Provide insulation manufacturers' recommended and matching adhesives and mastics, as required and as specified below to seal all gaps and reinforce vulnerable areas in vapor barrier. Provide with water based and low VOC formulations unless manufacturer documents superior performance of alternative recommendation and performance deficiencies of water based low VOC products.

6. Corrosion Inhibition Coating:

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Polyguard Brand, ReactiveGel™ RG-2400 series of coatings and accessories.

    b. Materials shall be compatible with insulation materials, jackets, substrates, and conditions of service. Provide product formulation specifically designed for the conditions of service.

    c. Product is a field applied gel chemical surface conversion compound utilizing reactive mineralization technology, creating a corrosion resistant mineral barrier 50-200 angstroms deep into the metal surface which increases in thickness as time passes.

    d. Viscosity: Brookfield method; 200,000-300,000 cps

    e. Specific Gravity: Gravimetric; 0.98-1.08

    f. Application: Spray, rag, brush, roll, glove.

    g. Corrosion test performance, thickness .025":

        1) 1000 hours Accelerated Weathering per ASTM B117 - pass with no corrosion.
        2) ASTM G-23 – pass with no corrosion.

    h. Service Temperature Range: Minus 40 to plus 350 deg F. depending on formulation.

    i. Color: Blue.

    j. V.O.C.: EPA Method; NONE

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
B. Verify that systems and equipment to be insulated have been tested and are free of defects.
C. Verify that surfaces to be insulated are clean and dry.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion inhibition coating to surfaces to be insulated as follows:

1. All non-galvanized ferrous components with a service temperature below ambient (chilled water and chilled water/glycol systems): Coat with one full coverage coat of specified corrosion inhibition coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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

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

3.3 INSTALLATION

A. General:

1. Provide thermal and acoustical insulation for components shown on the Drawings as specified in this Section for the following:

a. All heating and air conditioning systems piping including fittings, valves, and accessories.

1) Include removal of existing insulation and replacement insulation as specified for existing piping where existing insulation is damaged as a result of contract work.

b. All heating and air conditioning ductwork unless noted otherwise.

1) All heating and air conditioning ductwork labeled as exposed shall not be insulated unless noted otherwise.

2) All heating and air conditioning ductwork within a Mechanical Room, Boiler Room, Fan Room, etc., shall be insulated whether exposed or not.
3) Include re-insulation where insulation is removed as a part of the abatement work. Refer to abatement drawings for quantities.

c. All outside air ductwork extending from exterior wall or roof to the equipment which it serves.

d. Exhaust, return, and relief air ductwork not passing through air to air energy recovery devices prior to exiting the building: extending from exterior wall or roof 15 feet into the building envelope in all directions of duct branch take-offs.

e. Exhaust, return, and relief air ductwork that does pass through air to air energy recovery devices prior to exiting the system: insulate complete as described below.

f. All cooling condensate drain lines.

2. Comply with manufacturer's installation instructions and recommendations.

3. Do not begin mechanical insulation until permission is granted to begin mechanical insulation installation, hydronic systems have proved drip free under pressure, duct systems have passed required duct leakage requirements and testing, indoor work areas are weather tight, and outdoor work areas are at appropriate ambient conditions.

4. Below ambient temperature applications:

a. Provide corrosion inhibition coating as specified above.
b. Apply vapor barrier mastic and sealant to all open ends, joints, seams, breaks, and punctures in insulation.

5. Do not use any insulation support system which causes compression of insulation, localized or widespread, to less than 75% of the rated nominal thickness. Wires wrapped around rectangular duct insulation are not permitted as insulation support.

6. Provide for durable and repeated service access as part of insulation system.

a. Do not permanently cover inspection stampings, hand holes, manholes, plugged outlets, or similar features on equipment – provide removable labeled insulated access port with beveled and sealed insulation plug, gasketed if vapor barrier is needed, durably fabricated for repeated access.

b. Provide removable insulated boxes as specified for Pumps, Suction Diffusers, Heat Exchanger Frames and Heads, Triple Duty, Balancing, and Control valves, and other HVAC components needing periodic maintenance or adjustment.

7. Install thermal mechanical insulation as follows:

a. Only on clean, dry surfaces and after piping and ductwork has been tested and found to be tight.
b. Continuously through wall or ceiling openings and sleeves.
c. On cold surfaces with continuous unbroken vapor seal.

d. Insulate ducts and pipes individually.

8. Where more than one layer of insulation is required to achieve specified thickness or R value, apply thinner layer first, and stagger joints between insulation layers at least 3 inches.

B. Pipe Insulation

1. Comply with manufacturer's installation instructions and recommendations. Install only when ambient temperatures are within range recommended by manufacturer. STAPLES NOT PERMITTED.

2. Provide high impact plastic wrapper on all exposed, insulated piping from finished floor to 8 ft. above finished floor.

3. Interior Pipe and Fitting Insulation: Install on all heating, cooling, and condensate piping. Seal with factory applied pressure-sealing adhesive strip on the longitudinal lap. Seal butt joints with pressure-sealing adhesive strip at least 2 inches wide. Install valve and fitting covers in all locations.

4. Refrigerant Piping Insulation: Install in full accordance with manufacturers specifications and recommendations on refrigerant and condensate lines, using adhesive specifically intended for flexible foam plastic and provided by insulation supplier. Paint all exposed insulation cut ends with manufacturers (white) finish, similar to “WB Armaflex” or equal. Provide preformed elbows and fittings where available and neatly mitered and fit custom fabrications where manufactured components are not available. Tape and seal all joints vapor tight. For exterior refrigerant piping, install exterior piping protective wrapper water and air tight in accordance with manufacturer’s printed installation directions.

5. Insulation at Pipe Support: Refer to SECTION 23 05 29 - Hangers and Supports for material specifications of insulated piping support assembly and pipe support insulation. Complete insulation installation for the applicable pipe support insulation type to be used.

a. Type “B” Pipe Support Insulation:

1) Install pipe support insulation at hanger and support locations in conformance with manufacturer’s recommendations and as indicated on Drawings.

2) Remove a section of insulation from pipe insulation and replace this section with heavy density molded fiberglass blocks without breaking vapor barrier wrap.

b. Type “C” Pipe Support Insulation:

1) Provide butt connection to high-density insulation sections at pipe hangers as specified in Section 23 05 29 - Hangers and Supports.

2) Provide insulation with vapor barrier on upper half of insulated piping support assembly.

3) Apply wet coat of vapor barrier lap cement on butt joints and finish coat of vapor barrier mastic.

4) Tape edge of insulation section edge and insulation with white, pressure-sensitive PVC tape with tape extending over adjacent pipe insulation by at least 2 inches.

C. Ductwork Insulation: Provide external thermal insulation on ducts as specified or indicated on Drawings; external thermal insulation not required where ducts are shown or specified with internal acoustical insulation. Insulate and seal around duct dampers, damper motors, thermometers, instruments, access doors, and similar component as required without restricting operation or function. Insulate all ducts in all concealed spaces.

1. Use flexible type insulation on concealed ductwork with widths or diameters of 18 inches or less only. Insulate all other ductwork requiring insulation with rigid board type, semi-flexible type, or other type as required by drawings and specifications.

2. Duct Insulation Mechanical Fasteners: Provide mechanical fasteners for all duct surfaces over 12" wide. For duct surfaces 18'" wide and less, provide single row of fasteners down duct centerline. For duct surfaces over 18" wide, install minimum of 2 rows per side, applied on maximum 18" centers, starting within 3" of any edge.

   a. Pins with the point facing out accepting push washers: clip points close to washers and cover with vapor barrier adhesive and tape. Not permitted on mechanical room duct unless covered by puncture resistant protective wrapper.

3. Duct Insulation Tape: Apply only to clean dry dust free surfaces as recommended by tape manufacturer and as required for durable adhesion.

   a. Pealing tape, loose insulation, or otherwise broken vapor barrier subject to repeated recall.

4. Rigid Board Type Insulation Installation: Install board with all corners mitered or rabbeted; no butt joints allowed. Secure insulation with mechanical fasteners. Apply corner reinforcement angles (beads) on all corners for exposed ductwork (including in mechanical or storage spaces), with edge tape over beads. Seal all breaks and joints in vapor barrier with 3 to 5 inches wide insulation tape (minimum 1.5" tape past break all around).

5. Semi-flexible Type: Install similar to rigid board type, on round duct, curved elbows, etc.. Wrap curved and round surfaces taught, provide circumference tape band maximum two feet on center (butt joints and center of four foot roll stock).

6. Flexible Type Insulation Installation: Make all joints and seams with 2-inch lap of vapor barrier cemented with Benjamin Foster "BF85-20". Apply Benjamin Foster "BF-20" adhesive to ducts in 6-inch brush widths at 1 ft. intervals and at each facing edge. Tape all adhered with Benjamin Foster "BF-20". Tape seal all seams, breaks, and joints in vapor barrier, then continuously coat all tape with manufacturer's recommended vapor barrier adhesive

7. Acoustical Duct Lining: Install on low velocity ductwork as noted on Drawings, adhering to sheet metal duct with 100 percent coverage of adhesive meeting the requirements of ASTM C 916, and additionally securing with mechanical fasteners as noted above but on 12-inch centers maximum in the transverse direction. Seal all edges, transverse joints and fastener penetrations with approved mastic. Protect all exposed edges with metal nosing causing no greater than 10% compression of the liner.

8. Exterior Duct Work Insulation: Install insulation and covering in strict compliance with manufacturer's printed instructions and recommendations and as follows:

    a. Mechanically fasten insulation to duct.

    b. Slope top insulation a minimum ¼" per foot for positive drainage using tapered thickness panels, not shims with air gaps below.

    c. Tape joints and ruptures in facing, using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction ensuring vapor tight installation.

    d. Seal and protect exterior duct work insulation with Exterior Duct Insulation Covering, making all joints and terminations watertight with any and all special details as required by application.

    e. Mechanically support bottom of duct Exterior Duct Insulation Covering on all exterior duct 24 inches wide and wider such that there is no unsupported dimension over 30 inches. Provide transverse and if required longitudinal strut system compressing Exterior Duct Insulation Covering against bottom of duct. Refer to Section 23 05 29 – Hangers and Supports for HVAC Components, for details of corrosion resistance and construction of insulation support system.

    f. Provide for air pressure bleed ports in the bottom of insulation system of exterior positive pressure duct as required to bleed off duct leakage without pressurizing insulation system. Typical bleed port shall be similar to ¼" OD nylon tubing penetrating bottom of insulation full thickness of insulation, extending ½ inch below insulation cover, cut off at 45 degrees both ends, and sealed to insulation and covering with appropriate caulk. On vertical duct, slope down for drainage. Provide one bleed port for every 10 linear feet of exterior duct.

        1) Test and eliminate duct leakage before applying insulation system. If additional bleed ports are needed to prevent insulation covering from bulging out between supports due to internal pressure, remove insulation and reseal duct to control leakage.

D. Equipment, Tank, and Vessel Insulation Installation

1. Air Conditioning Service Diffusers:

   a. Install insulation materials in accordance with manufacturers written instructions. Clean and dry diffuser backs before installation. Use one piece covering entire back of diffusers where possible, adhered durably vapor tight especially at edges, with smooth and even surfaces, and neat hole cut to fit duct collar. Seal to duct insulation.

2. Pumps, Suction Diffusers, Heat Exchanger Frames and Heads, Strainers, Triple Duty Valves, Balancing and Control Valves, and other HVAC components needing periodic maintenance or adjustment:

   a. Provide removable covers as specified above.

   b. Fit covers closely to component being insulated and adjacent system insulation and coincide joints with component and adjacent equipment installations allowing easy removal for service access to all parts requiring service.

   c. Valves with insulated non-condensing stem assembly: insulate and seal to stem, leaving insulated adjustable portion of valve\s exposed.

3. Surface Finish of Equipment Insulation:

   a. Heating Equipment with no serviceable parts concealed: Reinforce insulation and cover with metal mesh and insulating cement. Recover with 8 oz. canvas, smoothly applied, adhered and sized with Benjamin Foster “BF-30" adhesive.

   b. Cooling Equipment with no serviceable parts concealed: Glue all joints with 100% adhesive coverage of cut surfaces. Seal assembly vapor tight as required to avoid condensation. Paint all exposed insulation edges with manufacturers (white) finish, similar to “WB Armaflex” or equal, and cover all joints with manufacturer’s matching protective vapor barrier facing tape.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.

1. See especially Section 01 08 00 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.2 SUMMARY

A. Section includes commissioning process requirements for the following Building Mechanical Systems, which are described in more detail in the technical specifications of Division 23.

1. Heat generation systems, including furnaces, and auxiliary equipment.
2. Cooling generation systems, including direct-expansion systems.
3. Distribution systems, including supply and return air distribution (heating and cooling) systems, hot water distribution systems.
4. Terminal and packaged units, including unit ventilators, cabinet unit heaters, fan-coil units, finned-tube radiation and packaged units.
5. Energy Management and Control System.
6. Systems testing, adjusting, and balancing verification, including all of the above mentioned systems.

1.3 DEFINITIONS

A. BAS: Building automation system, also known as Energy Management and Control System (EMCS).

B. Building Mechanical Systems: All Systems, Subsystems, Equipment, and Components of the building systems traditionally known as Heating, Ventilating, Air Conditioning, Refrigeration, Plumbing, and Electrical Works.

C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

D. CxA: Commissioning Authority –The Owner or a third party commissioning agent designated by the Owner.

E. DDC: Direct digital controls, a part of the BAS.

F. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

G. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

H. TAB: Testing, adjusting, and balancing.

1.4 SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: Provide construction pre-functional test checklists filled out by qualified technician for all equipment to be commissioned on this project, including but not limited to all :

1. BAS.
2. Heating-water piping and accessories.
3. Refrigerant piping.
4. Metal ducts and accessories.
5. Fans.
6. Particulate air filtration.
7. Air-handling units.

C. Certificates of readiness and completion of installation.

D. Test and inspection reports and certificates.

E. Corrective action documents.

F. Instrumentation Calibration Information

G. Functional Performance Test Procedures

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.

2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

3. One of the following:

    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
    b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
    c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

    a. Equipment/instrument identification number.
    b. Planned commissioning application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

    a. Capable of testing and measuring performance within the specified acceptance criteria.
    b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
    d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

    a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

        1) Instrument or tool identification number.

2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.

c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Provide mechanical work in accordance with contract document requirements.

B. Perform commissioning tests including Materials Checks, Installation Checks, Start-up Checks, Startups, and Functional Testing, all at the direction of the CxA.

C. Attend construction phase controls coordination meetings.

D. Attend and participate in TAB review and coordination meetings

E. Attend and participate in commissioning meetings.

F. Participate in Building Mechanical Systems maintenance orientation and inspection as directed by the CxA.

G. Prepare Construction / Prefunctional Checklists and Functional Performance Test procedures and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms for review and approval.

H. Submit documentation required for Commissioning work. At minimum, include: Detailed Start-up procedures, Full sequences of operation, Operating and Maintenance data, Performance data, checkout sheet forms used by factory or manufacturer's field technicians, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.

I. Review and approve other relative documentation for impact on Functional Performance Tests of the systems:

1. Shop Drawings and product submittal data related to systems or equipment to be commissioned. Review and incorporate comments from the CxA.

2. Incorporate manufacturer's Start-up procedures with Prefunctional checklists.

3. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the Functional Performance Testing.

4. Complete equipment Construction / Prefunctional Checklists, Start-up certification forms, and the manufacturer's field or factory performance and Start-up test documentation: review the documentation prior to commencing with the scheduled Functional Performance Tests.

5. Final Testing Reports: Contractor or Subcontractor performing the test will review the documentation prior to commencing with the scheduled Functional Performance Tests.

6. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the Functional Performance Tests, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

J. Provide information requested by the CxA for final commissioning documentation.

K. Schedule work so that required installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.

L. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

M. Inspect, check and confirm in writing the proper installation and performance of all Work.

N. Provide technicians to assist during system verification and functional performance testing as required by the CxA

1.7 CxA'S AUTHORITY

A. Directing Commissioning.

B. Assign Commissioning Agent for various commissioning tasks to stand in for the CxA.

C. Edit and approve project-specific construction checklists and commissioning process test procedures for actual Building Mechanical Systems, assemblies, equipment, and components to be provided as part of the construction contract.

D. Verify Testing, Adjusting, and Balancing of Work are complete.

1.8 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Building Mechanical Systems to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that Building Mechanical Systems and associated controls are ready for testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that Building Mechanical Systems have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that Building Mechanical Systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that Contractor portions of testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing report discrepancies have been corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Provide (Furnish and Install) measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.

B. Scope of Building Mechanical Systems testing includes entire HVAC&R installation. Testing includes measuring capacities and effectiveness of operational and control functions, accuracy and precision of sensing equipment, and other functional parameters as required, demonstrating that systems are performing as specified and intended. Commissioning testing includes verification of up to 30 percent of the control points, Testing and Balancing data, and other system requirements indicated in the individual technical sections, and on the drawings and schedules of these contract documents. Parameters not otherwise specified to be tested, as required to adequately demonstrate system performance, may constitute up to 10 percent of the 30 percent (3 percent of total).

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the Building Mechanical Systems Contractors and their Subcontractors, especially the Testing, Adjusting, and Balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for Building Mechanical Systems based on the actual installed equipment and the contract documents.

E. Perform tests using design conditions whenever possible.

1. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

2. The CxA may direct that set points be altered when simulating conditions is not practical.

3. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

F. If tests cannot be completed because of a deficiency outside the scope of the Building Mechanical System, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests. If deficiencies cannot be resolved, refine tests as required to adequately test Building Mechanical Systems within the constraints of the deficiency.

G. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.3 TESTING, ADJUSTING, AND BALANCING (TAB) VERIFICATION

A. Prior to performance of TAB Work, provide copies of approved sample report forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of TAB Work, and provide access for the CxA to witness Testing, Adjusting, and Balancing Work.

C. Subsequent to approval of formal TAB report, TAB Work will be subject to field verification. Provide technicians, instrumentation, and tools to verify testing and balancing of Building Mechanical Systems at the direction of the CxA. Roughly 10% of required TAB data points identified in TAB specification will be selected for subsequent field verification.

1. The CxA will notify TAB Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified..

2. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.4 SPECIFIC COMPONENT ANS SYSTEM COMMISSIONING TESTS

A. Heat Generation Systems

1. Furnace Testing: Field testing requirements are specified in Division 23 Section "Furnaces", Paragraph 3.4.A. Provide submittals, test data, inspector record, and furnace performance certification to the CxA.

B. Cooling Generation Systems

1. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested, as required demonstrating that any selected operating performance criteria are met or exceeded.

C. Air Distribution Systems

1. TAB Air Flow Verification:

a. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

b. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

c. Scope: HVAC&R air systems and hydronic piping systems.

d. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.

e. Conditions of the Test:

1) Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

2) Systems operating in full heating mode with minimum outside-air volume.

3) Systems operating in full cooling mode with minimum outside-air volume.

4) For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

f. Acceptance Criteria:

1) Under all conditions, rechecked measurements comply with "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

2) Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.

3) Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

D. Hot Water Distribution Systems

1. Heating-Water Supply Temperature Control:

a. Prerequisites: Installation verification of the following:

1) Startup of boiler.

2) Startup of heating-water pump(s).

3) TAB of heating-water flow and pressure.

4) Input Device: Heating-water supply temperature sensors, thermometers, and thermostatic devices.

5) Output Device: Control valve.

6) Display the following at the operator's workstation:

a) Heating-water supply temperature.
b) Heating-water supply temperature set point.
c) Control-valve position.

b. Scope: Heating-water system.

c. Purpose: Control of heating-water supply temperature at input device.

d. Conditions of the Test:

1) Minimum heating-water flow.
2) Midrange Heating-Water Flow: 50 to 60 percent of maximum.
3) Maximum heating-water flow.

e. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

2. Heating-Water Supply Temperature Reset:

   a. Prerequisites: Installation verification of the following:

      1) Startup of boiler.

      2) Startup of heating-water pump(s).

      3) TAB of heating-water flow and pressure.

      4) Input Device: Heating-water supply temperature sensors, thermometers, and thermostatic devices.

      5) Input Device: Outdoor-air temperature sensor;

      6) Output Device: Control valve.

      7) Display the following at the operator's workstation:

         a) Outdoor-air temperature.
         b) Heating-water supply temperature.
         c) Heating-water supply temperature set point.
         d) Control-valve position.

   b. Scope: Heating-water system.

   c. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device in response to variable outdoor-air temperature input; outdoor-air sensor.

   d. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.

      1) Low Temperature: Outdoor-air temperature between minus 30 and 0 deg F.
      2) Midrange Temperature: Outdoor-air temperature between 30 and 45 deg F.
      3) High Temperature: Outdoor-air temperature above 65 deg F.

   e. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within 2.0 deg F of set point.

      1) 160 deg F heating water when outdoor-air temperature is minus 10 deg F.
      2) 110 deg F heating water when outdoor-air temperature is 45 deg F.
      3) Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

3. Pump Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section “Testing, Adjusting, and Balancing for HVAC”. Provide submittals, test data, inspector record, VSD setup reports, and pump alignment certification to the CxA. Pumps shall deliver the design flow rate and pressure using no more energy than as scheduled. Pump alignment shall be as specified. VSD setup and adjustment shall be as specified.

4. Control Primary Circulating Pump(s):

a. Prerequisites: Installation verification of the following:

1) Startup of heating-water pump(s).

2) Input Device: Outdoor-air temperature; outdoor-air sensor.

3) Output Device: Heating-water pump; DDC system command to starter relay.

4) Display the following at the operator's workstation:

a) Outdoor-air temperature.
b) Operating status of primary circulating pump(s).

b. Scope: Heating-water pump(s) and associated controls.

c. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; outdoor-air sensor.

d. Conditions of the Test:

1) High Temperature: Outdoor-air temperature above 65 deg F.
2) Low Temperature: Outdoor-air temperature below 65 deg F.

e. Acceptance Criteria:

1) High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F.
2) Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F.

E. Air System Energy Recovery Systems

1. Energy Recovery Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and heat exchanger certification to the CxA. Heat exchanger shall exchange the energy flows scheduled with no greater pressure drop or approach temperatures than scheduled.

F. Air-Handling Units

1. Air-Handler Mixed-Air Control:

a. Prerequisites: Installation verification of the following:

1) Minimum Position Input Device: DDC system time schedule.

2) Output Device: DDC system analog output to modulating damper actuator(s).

3) Heating Reset Input Device: DDC system software.

4) Supply-Air Temperature Input Device: Electronic temperature sensor.

5) Display the following at the operator's workstation:

a) Mixed-air-temperature indication.
b) Mixed-air-temperature set point.
c) Mixed-air damper position.

b. Scope: Air handler with mixed-air control and associated controls.

c. Purpose:
1) Occupied time control.
2) Minimum damper position control.
3) Heating reset control.
4) Supply-air temperature control.
5) Cooling reset control.
6) Unoccupied time control.

d. Conditions of the Test:

1) Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.

2) Minimum Damper Position Control: Command system to mode in which minimum damper position is required.

3) Heating Reset Control: Create a call for heating.

4) Supply-Air Temperature Control: Override supply-air temperature set point to a value 2.0 deg F above current supply-air temperature.

5) Unoccupied Time Control: Advance to unoccupied schedule time.

6) Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply-air temperature control, and economizer cooling control.

a) Minimum position input device.
b) Heating reset input device.
c) Supply-air temperature input device.
d) Cooling reset input device.

e. Acceptance Criteria:

1) Occupied Time Control: Mixed-air control is active in occupied mode.

2) Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.

3) Heating Reset Control: Controller sets outdoor-air dampers to minimum position.

4) Supply-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply-air temperature set point plus or minus 1.0 deg F.

5) Economizer Cooling Control: Controller sets outdoor-air dampers to mazimum position when outdoor-air enthalpy is less than return-air enthalpy.

6) Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.

7) Control Data Trend Log: Data verifies control according to sequence of control.

G. Cabinet Unit Heaters

1. Cabinet Unit Heater Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and Cabinet Unit Heater performance certification to the CxA. Cabinet Unit Heaters shall be equipped with all accessories as specified and scheduled and shall be demonstrated to deliver the scheduled airflow and heat capacity at no greater noise or power use levels than specified.

H. Fan-Coil Units

1. Fan-Coil Unit Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and Fan-Coil Unit performance certification to the CxA. Fan-Coil Unit shall be equipped with all accessories as specified and scheduled and shall be demonstrated to deliver the scheduled airflow and heat capacity at no greater noise or power use levels than specified.

I. Finned-Tube Radiation

1. Finned Tube Radiation (FTR) Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, and test data certification to the CxA. FTR shall be installed level and plumb, neat and secure, with ready access to hydronic specialties as required for service, equipped with all accessories as specified and scheduled and shall be demonstrated to provide the specified and approved heating capacity while operating with no greater than the specified water flow.

J. Energy Management and Control System

1. Testing requirements are specified in Division 23 Section "Instrumentation and Control for HVAC", Section 3.11 SYSTEM TESTING AND COMMISSIONING. Provide submittals, test data, inspector record, and EMCS performance certification to the CxA.

2. Provide password and any other hardware and software as required to enable CxA to communicate directly, with full graphics and control capability, with the EMCS from the CxA's office over an internet browser interface. Install complete early in project.

K. Electrical Power Distribution Systems Serving he Above Listed Mechanical (Plumbing and HVAC&R) Systems

1. Be prepared for CxA to take thermal images of field connections for any line voltage power connections.

END OF SECTION 23 08 00

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Review and study all drawings and this entire project specification to become familiar with the equipment and system operation as designed and to verify the quantities and types of controllers, valves, dampers, operators, alarms, points, etc., required.

1.2 SUMMARY

A. This section describes the requirements for a complete Energy Management and Control System (EMCS) for building mechanical systems and components, based upon Direct Digital Control (DDC) logic including WEB served operator interface via one new computer Operator Work Station, distributed microprocessor controls, and integrated electronic components, interfaces, and actuation, all installed complete as specified.

B. Perform all work in cooperation with the Owner, Architect, Construction Manager, and other Prime Contractors. Coordinate all work with the construction schedule established by the Owner, Architect, and Construction Manager, and immediately report any delays including circumstances causing the delays.

C. It is the Owner's intent to establish a fully compatible and interoperable Energy Management and Control System (EMCS) network as an extension of the Wallkill School District's distributed Honeywell EMCS. This shall be accomplished through the general removal of all existing controls components serving these systems, and providing new controls complete as specified herein. Provide new graphic displays for all new controls, and custom configure graphic displays to meet Owner and Engineer requirements. Provide each of the following portions of the complete EMCS as a standalone system that can communicate with any other Direct Digital Control (DDC) system which is following the same protocol:

1. Operator Work Stations (OWS): Update software at existing EMCS complete to incorporate this addition. Provide guaranteed seamless two way communications from each, including full control, with the EMCS provided as a part of this project and the existing campus EMCS.

    a. The OWS shall monitor, display, and control information from the EMCS through one software package. Rebooting of the OWS, or opening a separate program to access the existing building's multiple systems is not acceptable.

    b. The OWS shall allow customization of the system as described in this specification.

c. The OWS shall:

1) Provide new color graphic control panels for all equipment provided or modified as part of this project, as outlined below and on the drawings,
2) Allow operators to view and work with all DDC points associated with all DDC equipment provided or modified as part of this project,
3) Allow operators to create custom graphics and/or control programming generation for any and all new equipment.

2. Network Control Unit (NCU): Provide central processor WEB server capability for and fully integrated two way communications with all energy use and management equipment provided or modified by this project, along with any third party stand alone controls provided by the manufacturers of the Air Handlers, Refrigeration Machinery, Boilers, and Variable Speed Drives. NCU shall be capable of supporting a minimum of 127 field devices, providing reserve capacity for addition of future points and expansion of DDC system into building. The DDC system's NCU shall communicate with the OWS entirely using the BACnet protocol, with a conformance class of 5, as defined in the latest officially amended version of ANSI/ASHRAE 135-2004.

3. Distributed Controls: System controls shall include but not be limited to all controllers, sensors, devices, wiring, and all other hardware and software required to perform all of the functions and controls described later in this specification and on the drawings, including fully integrated two-way control of boilers, chiller, condensing units, pumps, VSDs, heat exchanger, and all associated temperatures, pressures, and other controllable parameters of mechanical equipment and systems provided or modified as part of this project. Provide control through the EMCS as outlined in the general controls sequences of operations below, as shown on the project drawings, and with controls similar to as shown where the exact configuration is not explicitly covered by the drawing and specification sequence of operations.

4. Engineer's Office: Provide password and any other hardware and software as required to enable Engineer to communicate directly, with full graphics and control capability, with the EMCS from the Engineer's office over an internet browser interface. Install complete early in project. Engineer will utilize to check progress of installation, to check operation of system during the punch list period, and to monitor system operation after completion of the work.

1.3 DEFINITIONS

A. DDC: Direct Digital Control.

B. PC: Personal computer.

C. EMCS: Energy Management and Control System, includes the complete automatic temperature control and energy use management system specified herein, based upon DDC technology, incorporating all necessary input and output devices, connecting hardware, software, and accessories.

D. OWS: Operator Workstation which is the main operator interface with the EMCS, comprised of a PC with graphical two way interface with, and data base and control capabilities for, the entire EMCS.

E. UC: Unitary Controller, a version of the SCU which is a smaller microprocessor-based controller, possibly pre-programmed to function specifically for the operation of a particular piece of equipment, such as a standard configuration air handler, unit ventilator, variable air volume box, lighting circuit, etc.

F. SCU: Standalone Control Unit, a microprocessor-based controller panel, which contains all necessary control logic to carry out its own, local functions, and can function independently of other SCU panels and all remaining portions of the EMCS. The SCU may serve one or many types of HVAC equipment and is not factory programmed for only one purpose.

G. NCU: Network Control Unit, a secure central processing unit microprocessor based WEB server residing directly on the Owner's Ethernet TCP/IP LAN/WAN; providing direct communications to SCUs, UCs, and other field devices; integrating and processing their data and presenting it as custom HTML WEB pages in accordance with custom programmed graphical interface edited at an OWS.

H. LAN: Local Area Network - the Owner's existing Ethernet communications backbone which connects all of the owners buildings (and various rooms) on their campus. To be used by the Contractor where possible to connect OWSs, NCUs, SCUs, and UCs. Coordinate with Owner to determine extent of interconnection possible.

I. BACnet: A Data Communication Protocol for Building Automation and Control networks as defined in American National Standard ANSI/ASHRAE 135-1995, including any updates or revisions to this document.

J. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

K. MS/TP: Master slave/token passing.

L. I/O: Input/output.

M. Modbus: a serial communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs).

N. PID: Proportional plus integral plus derivative.

O. RTD: Resistance temperature detector.

P. System Modem: a modem which is installed on the EMCS so that a remote SCU, UC, or OWS can connect up to the LAN and can function the same as if it were locally-installed.

Q. System Printer: a printing device which is installed on the LAN so that all EMCS components can utilize it as an output device.

R. TCC: Temperature Controls Contractor - The entity responsible for the work described by this section of specifications.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a. Water Temperature: Plus or minus 1 deg F.
b. Water Flow: Plus or minus 5 percent of full scale.
c. Water Pressure: Plus or minus 2 percent of full scale.
d. Space Temperature: Plus or minus 1 deg F.
e. Ducted Air Temperature: Plus or minus 1 deg F.
f. Outside Air Temperature: Plus or minus 2 deg F.
g. Dew Point Temperature: Plus or minus 3 deg F.
h. Temperature Differential: Plus or minus 0.25 deg F.
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Pressurized Spaces): Plus or minus 3 percent of reading.
k. Airflow (Measuring Stations): Plus or minus 5 percent of reading.
l. Airflow (Terminal): Plus or minus 10 percent of full scale.
m. Air Pressure (Space): Plus or minus 0.01-inch wg.
n. Air Pressure (Ducts): Plus or minus 0.05-inch wg.
o. Carbon Dioxide: Plus or minus 50 ppm.
p. Electrical: Plus or minus 5 percent of reading.

1.5 QUALITY ASSURANCE

A. Provide all labor, material, equipment, software, and programming necessary to meet the functional intent of the EMCS, and the rigid requirements as specified herein and as shown on the drawings. Provide, without additional cost to the Owner, all equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent expressed in the sequences of operations herein or on the drawings. The contractor is responsible for all costs of changes in the work required by substitute equipment.

B. The TCC must have been in business for at least ten years, providing DDC systems as their primary business with documented success. They shall have a minimum of five years as a manufacturer's authorized distributor or branch office representative for one or more of the manufacturers specified. They must have a trained staff of application engineers, project managers, software engineers, commissioning staff, training staff, and service staff experienced in the configuration, programming and service of the EMCS. They must have a local service department and stock the manufacturer's standard replacement parts.

C. The EMCS shall be installed only by skilled mechanics employed directly by the TCC except wiring may be installed by their first tier subcontractor under the TCC project manager's direct supervision. Any subcontractor shall have documented success installing controls with the TCC for a minimum of five years prior to this project. Sub-contractual relations shall in no way relieve the contractor of any of their obligations under their contract.

D. The TCC shall have a training facility with regularly scheduled training as outlined below so as to provide ongoing regularly scheduled application training.

E. Manufacturer must be a firm regularly engaged in manufacture of microprocessor temperature control equipment, of configuration and capabilities similar to or better than specified equipment, for at least ten years, and must have similar earlier vintage models that have been in continuous satisfactory use for not less than ten years in similar service.

F. All work shall conform to the following Codes and Standards, as applicable to the Contracted Work at the Project job site and to the relevant Authorities Having Jurisdiction at the Project site. All products shall be labeled with the appropriate approval markings. In the case of conflict or discrepancy, the latest and most stringent regulation or code shall apply.

1. National Electrical Code (NEC) and applicable local Electrical Codes.
2. Underwriters Laboratories (UL) listing and labels.
3. Underwriters Laboratories of Canada (ULC) listing and labels.
4. UL 864 UUKL Smoke Control.
5. UL 864 UOJZ Fire Protection Signaling Systems.
6. UL-873; Temperature Indication and Regulating Equipment.
7. UL-916; Energy Management Systems for BAS components and ancillary equipment.
8. NFPA 70 – National Electrical Code.
9. NFPA 92A and 92B Smoke Purge/Control Equipment.
10. Factory Mutual (FM).
11. American National Standards Institute (ANSI).
12. National Electric Manufacturer's Association (NEMA).
13. American Society of Mechanical Engineers (ASME).
14. Institute of Electrical and Electronic Engineers (IEEE).
15. American Standard Code for Information Interchange (ASCII).

16. Electronics Industries Association (EIA).
17. Occupational Safety and Health Administration (OSHA).
18. American Society for Testing and Materials (ASTM).
19. Federal Communications Commission (FCC) including Part 15, R.F. Devices.
20. Americans Disability Act (ADA).
21. Uniform Building Code (UBC).
22. NEMA 250 – Enclosures For Electrical Equipment (1,000 V Maximum).
23. NFPA 101 – Life Safety Code.
24. IESNA – Illumination Engineering Society of North America.
25. UL 50 – Cabinets and Boxes.

1.6 GUARANTEES

A. Guarantee the EMCS complete to be free from defects in durability, materials, and workmanship, except for damages from other causes, for a period of one year after final acceptance.

B. Guarantee System to:

1. Maintain temperatures within +/- 1°Fof setting, within capacity of HVAC equipment.

C. Provide a one (1) year maintenance agreement to run concurrently with the Guarantee period, consisting of 24 hour emergency service and scheduled service (once per month minimum), as required addressing reported issues, for inspection and adjustment of operating controls, and replacement of parts or instruments found deficient or defective during this period.

D. Provide system backup and restore, software, programming, and sequence of operations enhancements, revisions, and adjustments at no charge to the Owner both during construction and commissioning and during this warrantee period.

1.7 SEQUENCE OF OPERATION

A. Refer to controls schematic drawings including written sequence of operations for specific pieces of equipment. Provide controls as specified and as required to achieve sequence of operations shown on drawings as well as specified below in general programming, and with controls similar to as shown where the exact configuration is not explicitly covered by the drawing and specification sequence of operations.

1.8 SUBMITTALS

A. Submit on controls in multiple portions as job progresses Include in each submittal a summary just inside the cover sheet of previously approved portions of submittal, currently submitted portions, and those portions not submitted yet. During closeout documentation, assemble all approved controls submittals into one package designed for use as both an installation and a maintenance manual.

B. Submit a Technical Proposal within 30 days of contract award, complete with the diagrams, Specification Compliance Reports, product information, and supporting documentation outlined below. Arrange the Technical Proposal in order of the specification article numbers, with tabs (bookmarked .pdf files for electronic submittals) at each division. The Technical Proposal shall be designed for use as both a clear demonstration of qualifications and as an installation and maintenance manual.

C. Include the following in a complete Technical Proposal:

1. Description of service capabilities including resumes for service technicians and designers that will be responsible for this project.

2. A list of local jobs (three minimum) of similar type and size the bidder has installed, utilizing the products proposed for this project, with Owner's representatives and engineer of record's names and telephone numbers for reference. This list should directly reflect:

    a. Projects that include direct integration to third party microprocessor controllers of the type specified within this scope.

3. Submit name of any proposed installation subcontractors, along with their statement of qualifications, resumes for service technicians who will be responsible for this project, and 3 local references for comparable recent jobs.

4. EMCS network wiring diagram showing interconnection of all panels, workstations, system printer(s) etc. A diagram describing system architecture for this project with product code numbers for workstation, network controllers, application specific controllers, transducers, sensors, communication networks, etc.. Diagram shall include all components intended to be used to meet or exceed specification requirements, shown in their functional relation to one another.

5. Provide information on owner training provided as part of the bid package as well as additional opportunities and factory schools available with associated costs. Include details of Operator HVAC Training System as specified herein.

6. Specification Compliance Report. The specification compliance report shall address every paragraph within this specification (230900), utilizing an outline format indicating clearly how the proposed system complies with this specification as follows:

    a. No Exception - proposed system complies without exception to both the letter and intent of this specification. Include Data Communications Protocol Certificates certifying that each proposed DDC system component complies with ASHRAE 135.

    b. Substitution Exception - proposed system is believed to meet the functional intent, but not the letter of the specification. For each paragraph for which a Substitution Exception is taken, the Specification Compliance Report shall identify all deviations from what is specified in the given paragraph and provide a complete description of what is included and how the proposed substitution meets the functional intent.

c. Non-Compliance Exception - proposed system does not meet specification letter or functional intent, and the contractors intent is that the paragraphs requirements will not be provided. For each paragraph for which a Non-Compliance Exception is taken, the Specification Compliance Report shall identify all deviations from what is specified in the given paragraph and provide a complete description of what is included and why the contractor believes their proposed system should still be considered in spite of the non-compliance

d. For all paragraphs indicated as "No Exception" or "Substitution Exception", provide and reference factory product documentation to substantiate compliance.

7. Hardware Product Data Bulletins for all specified products, including PC components of OWS. Each bulletin shall describe product features, model numbers and manufacturer's name.

8. Software Product Data Bulletins for all specified software features. Each bulletin shall describe product features, model numbers, and manufacturer's name.

D. As job progresses and in ample time for review and iteration as required for complete approval, submit the following:

1. Complete written description of all proposed control sequences and control strategy, with any deviations from the specified sequence of operations highlighted and explained.

2. Detailed wiring and piping control diagrams and system description for each system.

3. Detailed layout and nameplate list for all control panels, including pneumatic, unit-specific controllers, data-gathering panels, microprocessor-based panels, third party microprocessor controllers, etc.

4. Damper schedule giving size, type, velocity, pressure drop, configuration, location, and number, type, and size of motorized actuators. Include apparatus bulletins and data sheets. Include all existing to remain dampers proposed for reuse along with comments on condition.

5. Valve schedule giving valve identification tag abbreviation, location, service, failsafe position, pipe size, valve size, make/model, type, configuration, design flow, capacity index (cv), and pressure drop. Include apparatus bulletins and data sheets.

6. Schedule showing direct integration to all third party microprocessor controllers included in this project, including all points available in a point listing describing point type (analog input, binary input, analog output and binary output), point address, units, applicable software interlocks (alarm, interlock, sequence, etc.), and a verbal description of the function and intended control of the point.

7. Termination schedule and point listing describing point type, (analog input, binary input, analog output and binary output), physical point location (eg. AHU #1 mixed air) and software interlocks (alarm, interlock, sequence, etc.).

8. A complete listing of inputs and outputs, control loops and/or routines, timing functions, and facilities management system functions for each controlled system. This listing shall include point logical names and identifiers.

9. For all equipment, submit copy of written installation, maintenance, and operating directions and details, along with manufacturer's printed installation instructions for all equipment furnished, showing required installation and location of the above items.

10. Provide a sample of program language and description of how programming is accomplished.

11. Color printout sheets of representative samples of all proposed graphics and text based OWS pages.

E. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.9 RELATED AND ANCILLARY WORK

A. Electrical control wiring associated with building fire alarm system and duct smoke detectors: Installation is specified under Division 26.

B. Power source wiring for general (non-controls) HVAC motorized equipment: Installation specified under Division 26.

C. Provide power source and controls wiring for all EMCS equipment, complete back to breakers designated as temperature control power breakers on electrical drawings or other approved electrical power panel space. Includes all controls power source wiring, communication wiring, and actuated device power and control wiring. Installation specified both herein and in applicable sections of Division 26.

D. Piping work as required to maintain pressure tight integrity of all hydronic, potable water, and refrigerant based systems for the installation of all piping mounted controls components, including control valve installation, valve and control manifolds, pressure and temperature taps, flow switches, thermal wells, and similar devices: Installation specified both herein and under applicable piping section.

E. Sheet metal work as required to maintain pressure tight integrity of all airside systems for the installation of all airside mounted controls components, including dampers, pressure and temperature probe taps, flow sensors, and similar devices: Installation specified both herein and under applicable sheet metal and ductwork sections.

F. Insulation work as required to maintain the thermal integrity of the various systems associated with and subsequent to controls component installations: Installation specified in Division 23 section on Insulation.

G. For all equipment: Provide and follow written installation directions and details, with manufacturer's printed installation instructions for all equipment furnished, showing required installation and location of the above items.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for submittal, approval, fabrication, and shipping of control devices to equipment manufacturer in ample time for factory installation without impacting project schedule.

B. System Software: Update to latest version of software at Project completion.

1.11 INSTRUCTION AND TRAINING

A. Interactive Operator HVAC Training System

1. General:

a. Provide necessary software and learner workbooks to form a complete HVAC training system as described in this specification. Provide two (2) copies of the software and three (3) copies of the learner workbooks for the Owner's use.

2. Operation:

a. Usable by multiple students while maintaining records and bookmarks for each learner.

b. Operates from internet without the necessity of installing the program on a hard disk, or installed on hard drive. Students records stored on the computer's hard drive.

3. Features

a. Integrates text and graphics to explain the concepts of building environments, the systems that deliver these environments, and the controls that manage these systems.

b. Modular in design to allow the student to select and view whichever sections are appropriate in any order desired.

c. Menu driven with complete sections identified on the menu.

d. Includes a glossary of terms readily accessible from within the lessons allowing the review of a definition without losing the current lesson location.

e. Incorporates navigational aids including a learning map that allows the student to move directly to a desired section from the map.

f. Includes a password protected registration system to record student responses and bookmark progress. The registration system shall allow students to return to their previous lesson location or start the lesson again when logging on after the first session.

g. Includes a password protected mentor mode which can be used to monitor progress throughout the training program.

h. Includes mastery exam for each of the three sections of the training program; environments, systems, and controls.

i. Includes a final test, enabled by the mentor, to assure satisfactory completion of the learning program.

j. Includes a completion form upon successful completion of the training experience.

B. Include in closeout documentation signed letter of acknowledgment of receipt of factory authorized training, videotapes, and maintenance manuals.

1.12 COORDINATION

A. Coordinate all controls work required for a complete operable controls system as specified. Carefully review project summary and scoping documentation and coordinate with contractors responsible for various ancillary portions of controls work. Where supportive or ancillary work is not specifically assigned to another contractor, provide complete as required for a complete operable system.

B. Coordinate equipment with Division 28 Sections on Fire Detection and Alarm Systems to achieve compatibility with equipment that interfaces with that system.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

D. Coordinate equipment with Division 26 Sections on Electrical Power Monitoring and Control to achieve compatibility of communication interfaces.

E. Coordinate equipment with Division 26 Sections on Panelboards to achieve compatibility with starter coils and annunciation devices.

F. Coordinate equipment with Division 26 Sections on Motor Controls to achieve compatibility with motor starters and annunciation devices.

G. Coordinate size and location of concrete bases. Refer to Section 23 05 00 – COMMON WORK RESULTS FOR HVAC SYSTEMS for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Temperature Control Sub-Contractors (TCCs): Existing Energy Management and Control System (EMCS) and Basis of Design Energy Management and Control System (EMCS) isHoneywell. Subject to compliance with requirements, available TCCs offering products and services that may be incorporated into the Work include, but are not limited to, the following:

1. Automated Logic Controls as installed by Logical Control Solutions.
2. Delta Controls as installed by EMCOR Services Tri-Tech.
3. Johnson Controls Incorporated as installed by JCI.
4. Schneider Electric Controls as installed by Day Automation.
5. Siemens Controls as installed by Siemens Building Technologies, Landis Division.
6. TAC / Tridium / Niagara Controls as installed by TBS, Inc.

B. In other Part 2 articles where specific components are described, the basis of design and named equivalent TCCs integrate multiple manufacturers' components into a coherent system. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified:

1. Armstrong
2. Automated Logic Corporation.
3. Functional Devices Inc.
4. Honeywell International Inc.; Home & Building Control.
5. Invensys Building Systems.
6. Johnson Controls, Inc.; Controls Group.
7. KMC Controls/Kreuter Manufacturing Company.
8. McQuay International.
9. Siemens Building Technologies, Inc.
10. Schneider Electric
11. Solidyne Corp.
12. Staefa Control System Inc.; Siemens Building Technologies, Inc.
13. TAC Americas, INC.
14. TCS/Basys Controls.
15. Tekmar Control Systems, Inc.
16. Teletrol Systems Incorporated.

17. Tour & Andersson Control, Inc.
18. Trane; Worldwide Applied Systems Group
19. Triangle MicroSystems, Inc.
20. Victaulic, Inc.
21. Voltec, Inc.

2.2 GENERAL SYSTEM ARCHITECTURE

A. The EMCS shall consist of the following:

1. Operators' Workstations (OWS).

2. File Server (FS).

3. Network Control Units (NCU).

4. Standalone Control Units (SCU).

5. Application Specific Unitary Controllers (UC).

6. All controls power wiring 120 volts or less, all network and communication wiring, fiber optic cable, and other controls communication media.

7. All EMCS communications devices.

8. All related field devices including remote I/O cabinets, transformers and power supplies, relays, contactors, transducers, switches, cabling, and related electronic control equipment.

9. All necessary software and custom programming, including graphics and reports.

10. All necessary inputs, outputs, and devices required to meet the features and intent described herein including but not limited to:

    a. Transducers.
    b. Water flow switches and sensors.
    c. Differential Pressure sensors.
    d. Hydronic control valves.
    e. Opposed blade (control) or parallel blade (shutoff), low leakage dampers.
    f. Temperature, pressure, and humidity sensors and safety devices.
    g. Electronic valve and damper actuators.

11. All other equipment necessary for a complete, operational, EMCS.

B. The design of the EMCS shall network OWSs, FCs, NCUs, SCUs, UCs, and all sensors, safeties, actuators, and other devices. Inherent in the system's design shall be the ability to expand or modify the network via the Internet, the Level 1 LAN, the Level 2 bus, or via auto e-mail or auto-dial telephone line modem connections, or via a combination of all four networking schemes. LAN communications between buildings shall be standard ETHERNET TCP/IP and shall be compatible with the district's existing ETHERNET LAN.

C. The EMCS shall:

1. Be modular in nature, with distributed controllers operating in multi-user, multi-tasking environment on token-passing network.

2. Be re-programmable and programmed to control mechanical, electrical, and plumbing systems.

3. Be capable of integrating multiple building functions, equipment supervision and control, alarm management, energy management, historical data collection, and archiving.

4. Permit expansion of both capacity and functionally through the addition of components and programming.

5. Include an operator workstation which permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

6. Not be dependent upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. The system architecture shall consist of no more than two communication levels as follows:

1. Level 1 shall be on the Owner's ETHERNET LAN as possible within the constraints of this specification. Contractor shall field verify extent and capacity of existing LAN with Owner prior to creation of network layout drawings, and shall include any and all extensions of the LAN required for complete and robust functioning of the EMCS:

   a. Level 1 communications shall use the BACnet protocol.

   b. This LAN operates under ETHERNET protocol at 10 Mbps or other speed as determined by the Owner. The Level 1 LAN will provide transfer of point data, alarms and file activity among OWSs, NCUs, and SCUs.

   c. Any data from a Level 2 controller can also be transmitted onto this bus through a Level 1 controller. The high speed LAN shall support multi-user communications and multi-session activity. That is, all global data sharing shall occur simultaneously with the transmission of alarm data or user activity.

   d. OWSs and NCUs shall reside directly on the LAN such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations, on a peer-to-peer basis.

   e. SCUs and UCs may reside directly on the Level 1 Lan at the TCCs option.

2. Level 2 shall be on a EIA-485 bus or other comparable technology, designed to support a family of dedicated local controllers for control of HVAC equipment and lighting. The Level 2 bus shall communicate bi-directionally with the Level 1 LAN through NCU controllers for transmission of global data:

    a. The Level 2 bus, or field bus, shall support local control units (SCUs and UCs) of modular size for operation of the building's HVAC and lighting systems. This bus shall operate at a minimum speed of 200 kbps with a length of 4000 feet and 10Mbps with a length of 150 feet, with 32 nodes before requiring a network repeater. A minimum of 127 controllers shall be configurable on the field bus.

    b. The field bus shall permit peer-to-peer communications among all Level 2 controllers and allow simultaneous communications with portable computer service tools that are connected to a Level 2 controller. Failure of any Level 1 NCU controller shall not impair the operation of its associated field bus.

    c. All Level 2 field wiring that connects non native BACnet unitary controllers shall have an additional wiring set run in parallel dedicated for future use by native BACnet replacement controllers.

E. NCUs shall be able to access any data from, or send control commands and alarm reports directly to any other NCU or combination of NCUs on the network without dependence upon a central processing device. NCUs shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

F. Dynamic Data Access:

1. All operator devices, network resident, internet connected, or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the LAN. Access to data shall be based upon logical identification of building equipment.

2. Access to system data shall not be restricted by the hardware configuration of the EMCS. The hardware configuration of the EMCS network shall be totally transparent to the user when accessing data or developing control programs.

3. All points contained on Level 1 and Level 2 controllers shall be considered global points. Any program in any controller on the network shall be able to reference any point in any controller regardless of its location on the network.

G. General Network Design:

1. Network design shall include the following provisions:

    a. Data transfer rate for alarm reporting, report generation from multiple controllers, and upload/download between SCUs and OWSs shall be a minimum of 2.5 Megabaud.

    b. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.

c. Detection and accommodation of single or multiple failures of either OWSs, SCUs, or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

d. Message and alarm buffering to prevent information from being lost.

e. Error detection, correction, and re-transmission to guarantee data integrity.

f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.

g. Commonly available, multiple sourced, networking components and Ethernet protocols shall be used to allow the EMCS to coexist with other networking applications on the Owner's existing LAN/WAN. Ethernet and BACnet are acceptable technologies. BACnet system shall conform to the latest ASHRAE Standards and recommendations.

h. Use of an industry standard IEEE 802.x protocol.

i. Provide synchronization of the real-time clocks in all EMCS panels.

2.3 NETWORK CONTROL UNITS (NCUs)

A. General: Network Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each NCU control panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of NCUs shall be supplied to fully meet the requirements of this specification and the controls requirements shown on the drawings.

1. Basis of design NCUs: Schneider Electric Continuum bCX1-CR-xxx with InfbCX1 controller.

B. Webserver Functionality: All NCUs shall reside directly on the Owner's Ethernet TCP/IP LAN/WAN and shall be capable, out-of-the box, to be set up as a Web Server. The NCU shall have the ability to store HTML code and "serve" pages to a web browser. Provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer™, Netscape Navigator™, etc.) to access real-time data from the entire BAS via any NCU.

1. Graphics and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.

2. The WEB server interface shall be capable of password security, including validation of the requesting PC's IP address. The WEB server interface shall allow the sharing of data or information between any controller, process, or network interface (BACnet, LonTalk and TCP/IP) that the BMS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.

3. The BAS network controller must act directly as the WEB server. It must directly generate HTML code to the requesting user (i.e. WEB browser), eliminating the need for and reliance on any PC-based WEB server hardware or software. To simplify graphic image space allocation, HTML graphic images, if desired, shall be stored in any shared network device. The BAS Web server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. External WEB server hardware and software are not acceptable.

C. Hardware Specifications

1. Memory: A minimum of 4MB of RAM shall be provided for NCUs with expansion up to 8MB. The 8MB versions shall include a floating-point math co-processor.

2. Communication Ports: Each NCU shall provide communication to both the Workstation(s) and the field buses. In addition, each NCU shall have at least three other communications ports that support a telephone modem, portable service tool, serial printer and connection to third party controllers such as a chiller control panel. On a LAN/WAN system, the NCU shall be provided with a 10Mbps plug-in Ethernet TCP/IP network interface card (NIC).

3. Input/Output (I/O): Each NCU shall support the addition of the following types of inputs and outputs:

   a. Digital Inputs for status/alarm contacts
   b. Counter Inputs for summing pulses from meters.
   c. Thermistor inputs for measuring temperatures in space, ducts and thermowells.
   d. Analog inputs for pressure, humidity, flow and position measurements.
   e. Digital Outputs for on/off equipment control.
   f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

4. Modular Expandability: The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

5. Real Time Clock (RTC): Each NCU shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. In normal operation, the system clock shall be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

6. Power Supply: The power supply for the NCUs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (–48 VDC).

7. Automatic Restart After Power Failure: Upon restoration of power after an outage, the NCU shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

8. Battery backup: Each NCU with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or, a minimum of 2 hours of full UPS including modem power. This power backup system shall be configurable such that at the end of a settable timeframe (such as 1 hour) of running on full UPS, the unit shall shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

D. Software Specifications

1. General: The NCU shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. There shall be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

2. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

E. Control Software:

1. The NCU shall have the ability to perform the following pre-tested control algorithms:

   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

2. Mathematical Functions: Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These shall be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

3. Energy Management Applications: NCUs shall have the ability to perform any or all of the following energy management routines:

   a. Time of Day Scheduling
   b. Calendar Based Scheduling

c. Holiday Scheduling
d. Temporary Schedule Overrides
e. Optimal Start
f. Optimal Stop
g. Night Setback Control
h. Enthalpy Switchover (Economizer)
i. Peak Demand Limiting
j. Temperature Compensated Duty Cycling
k. CFM Tracking
l. Heating/Cooling Interlock
m. Hot/Cold Deck Reset
n. Free Cooling
o. Hot Water Reset
p. Chilled Water Reset
q. Condenser Water Reset
r. Chiller Sequencing

4. History Logging: Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32,767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

5. Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms shall be tested each scan of the NCU and can result in the display of one or more alarm messages or reports.

6. Up to 8 alarms can be configured for each point in the controller.

   a. Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.

   b. Alarms shall be generated based on their priority. A minimum of 255 priority levels shall be provided.

   c. If communication with the Operator Workstation is temporarily interrupted, the alarm shall be buffered in the NCU. When communications return, the alarm shall be transmitted to the Operator Workstation if the point is still in the alarm condition.

7. Reporting: The NCU shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.4 STANDALONE CONTROL UNIT (SCU) PANEL

A. SCUs shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors designed to integrate multiple Unitary Controllers, provide central processing capacity and integration of distributed processing, and interface directly with the system OWS and LAN.

B. Each SCU panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification.

C. The basic elements of the direct digital control system structure shall consist of standard components kept in inventory by the equipment supplier. The components shall not require customizing other than setting jumpers and switches, adding firmware modules or software programming to perform required functions.

D. The system shall be capable of being expanded to its full capacity by adding sensors and entering programs in available random access memory (RAM). Future expansion shall not require hardware modifications to the controller.

E. SCU shall be listed in accordance with UL 864 as required to provide direct control of all smoke dampers.

F. Memory: Provide with sufficient memory to meet system performance requirements and support its own operating system, database system, and database including:

1. Control processes
2. Energy management applications
3. Alarm management
4. Historical/trend data for all points
5. Maintenance support applications
6. Custom processors
7. Operator I/O
8. Dial-up communications
9. Manual override monitoring

G. Point Types: Support the following types of point inputs and outputs:

1. Digital inputs for status/alarm contacts
2. Digital output for on/off requirement control
3. Analog inputs for temperature, pressure, humidity, flow and position measurements.
4. Analog outputs for valve and damper position control, and capacity control of primary equipment.
5. Pulse inputs of pulsed contact monitoring.

H. Expandability:

1. The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.

2. The system architecture shall support expansion capacity of all type of SCU panels, and all point types included in the initial installation.

I. Serial Communication Ports: Provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such a industry standard printers, laptop workstations, PC workstations, and panel mounted or portable Operator's Terminals. SCU panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

J. Hardware Override Switches:

1. Provide the ability to manually override automatically executed commands at the SCUs via local, point discrete, onboard hand/off/auto operator override control via local keypad function for binary control points and with modulating control for analog control type points.

K. Hardware Override Monitoring:

1. SCU panel shall monitor the status or position of all override, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. EMCS panel shall also collect override activity information for daily and monthly reports.

L. Local Status Indicator Lamps:

1. The SCU panel shall provide local status indication for each binary input and output for content, up-to-date verification of all point conditions without the need for an operator I/O device.

M. Integrated On-Line Diagnostics:

1. Each SCU panel shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all subsidiary equipment. The SCU panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each SCU panel, and shall not require the connection of an operator I/O device.

N. Sure and Transient Protection:

1. Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induces voltage transient consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all single wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

O. Power failure:

1. In the event of the loss of normal power, there shall be an orderly shutdown of all SCU panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

2. Upon restoration of normal power, the SCU panel shall automatically resume full operation without manual intervention.

P. No digital control panel shall be loaded to more than 80% of its total available point capacity of the digital/analog/input/output sections.

Q. The SCU shall perform its assigned control and energy management functions as a stand-alone unit. Stand-alone control shall include, but not be limited to:

1. Supply and/or water reset.
2. Adaptive optimal start.
3. Time of day start/stop.
4. Zero energy band.
5. Night purge/warm-up.
6. Duty cycle.
7. Control valve, damper, motor and alarm capabilities.

R. EMCS Shall Operate Within The Following Limits:

1. Temperature 32°F to 120°F.
2. Humidity 0 to 95% RH.
3. Voltage +/- 10%.

S. Control algorithms shall be available and resident in the EMCS to permit proportional, integral, derivative, incremental, floating and two position control modes in combination to meet the need of the application and to adapt to job conditions.

T. Control shall be performed in a digital manner using the digital signal from the microprocessor based controller converted through electronic circuitry for modulation of electric or pneumatic actuators. This may take the form of a pulse width modulated signal or a true analog signal generated through a D/A convertor. Electro-pneumatic transducers used for pneumatic outputs shall be cabinet mounted either within the controller or in separate cabinet located immediately next to the digital control panel.

U. Adjustments of control variables shall be available at the controller with the modem through a non-intelligent terminal. Hand held or mounted in cabinet face. If hand held devices are provided two shall be furnished. These adjustments shall include, but not be limited to, setpoints, proportional gain, integral rates, the velocity and acceleration constants associated with incremental control and on/off values of two-position control.

V. The controller shall contain necessary mathematic, logic, utility functions, all standard energy calculations and control functions in ROM. These should be available in combination for programming the unit. These routines shall include, but not be limited to:

1. Math routines:

a. Basic arithmetic.
b. Binary logic.
c. Relational logic.
d. Fixed formulas for psychrometry.
e. Calculations.

2. Utility routines for:

    a. Process entry and exit.
    b. Keyboard functions.
    c. Variable adjustments and output.
    d. Alarm indication.
    e. Restart.

3. Control routines for:

    a. Signal compensation.
    b. Loop control.
    c. Energy conservation.
    d. Timed programming.

W. Final field programs shall be stored in battery backed up RAM. The EMCS (SCUs, UCs, etc.) shall be supplied with a minimum of eight hours of battery backup for the RAM with an automatic battery charger.

X. The EMCS shall be expandable by adding additional SCUs, UCs, etc., that operate through the processor of the EMCS.

Y. Provide digital sensors, differential air and/or water flow switches, space temperature sensors (30°F to 90°F), outside and air temperature sensors (-30°F to 120°F), hot water temperature sensor (0°F to 300°F), chilled water sensors (30°F to 90°F), humidity sensors, static pressure sensors, and other sensors and switches required to perform functions as specified.

Z. Provide transducers, EP switches, devices, required by the EMCS to position the control elements.

AA. Provide electric and pneumatic interface devices.

BB. The EMCS software shall contain a self-test procedure for checking the annunciator lights on the digital display, and the computer.

CC. Variable shall be identified as being reliable or unreliable. When a calculation is required to use a value (sensed or calculated), which is identified as being unreliable, the unreliable data value will flash. The calculation will use a default value programmed into the unit.

DD. Alarms (e.g. a pump that did not start) and deviation alarms (e.g. temperature out of limits) will be annunciated.

EE. The SCUs, UCs, shall be enclosed in a metal cabinet. The cabinet shall be constructed such that it can be mounted and electrical terminations made during the construction phase of the project.

FF. The EMCS cabinet shall be a hinged metal type with a baked enamel finish and provided with a key lock. Cabinets on each installation shall utilize one master key. Control wiring and system communications shall be electrically terminated inside the EMCS on a suitable termination board.

2.5 CONTROL UNITS

A. Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

B. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

C. Stand-alone mode control functions operate regardless of network status. Functions include the following:

1. Global communications.
2. Discrete/digital, analog, and pulse I/O.
3. Monitoring, controlling, or addressing data points.
4. Software applications, scheduling, and alarm processing.
5. Testing and developing control algorithms without disrupting field hardware and controlled environment.

D. Standard Application Programs:

1. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.

2. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.

3. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.

4. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.

5. Remote communications.

6. Maintenance management.

7. Units of Measure: Inch-pound and SI (metric).

E. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

F. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

2.6 LOCAL CONTROL UNITS

A. Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

B. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

C. Stand-alone mode control functions operate regardless of network status. Functions include the following

1. Global communications.
2. Discrete/digital, analog, and pulse I/O.
3. Monitoring, controlling, or addressing data points.

D. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

E. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

2.7 I/O INTERFACE

A. Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

B. Binary Inputs: Allow monitoring of on-off signals without external power.

C. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

D. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

E. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.

F. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).

G. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

H. Universal I/Os: Provide software selectable binary or analog outputs.

2.8 POWER SUPPLIES

A. Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

B. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.9 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.10 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

2.11 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Air Flow Stations:

1. True average multipoint electronic sensing – pressure averaging with single electronic p-e converter not approved.
2. +/- 5% of reading accuracy from 0 to 5000 fpm, +/-0.25% repeatability.
3. Sealed "bead in glass" thermisters mounted in extruded aluminum tubular probes, spacing and length as required for application.
4. Provide each air flow station complete with factory calibrated transmitter integrated with controls system.
5. Design Make: Ebtron, series and configuration as required for specified accuracy.

C. Current Transducer:

1. Solid or split core self powered analog current transducer slips over power wiring to provide combination load status and power use trending data.

    a. Linear output from 0 to full scale.
    b. 0-5Vdc output
    c. Operating conditions: -15-60 deg C, 0-95%rh.
    d. 2 second response time
    e. Use solid core for new applications, split core for retrofits away from terminals.
    f. Split core +/- 2% of full scale accuracy from 10% to 100%.
    g. Solid core +/- 2% of reading accuracy from 10% to 100%.
    h. Similar to Hawkeye 722, 922/932, size and range as required for load.

D. Status Sensors:

1. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

E. Static Pressure Transmitter / Transducer:

1. Senses differential gauge (static) pressures and converts this pressure difference to a proportional analog output signal.

    a. Variable capacitance type, with stainless steel diaphragm and insulated positioning electrode.
    b. Voltage Requirement (input): +/- 12 V DC.
    c. Output: linear, 4 to 20 mA or 0 - 5 V DC.
    d. Pressure ranges 0 to 0.1 in w.g. through 0 to 25.0 in. w.g.
    e. Over Pressure Protection: Minimum 10 x full scale.
    f. Pressure Part Volumes: Positive part - 0.020 $in.^3$; reference part - 2.0 $in.^3$
    g. Accuracy: +/- 1% full scale (includes non-linearity hysteresis and non-repeatability).
    h. Factory calibrated with zero span adjustment capability.
    i. Temperature compensated output over the entire operating temperature range.
    j. Operating Environments: 40 deg. F to 100 deg. F.

F. Carbon Dioxide sensor / transmitter

1. Carbon Dioxide transmitters shall be used for demand controlled ventilation strategy discussed in the control sequence portion of this specification.

2. The CO2 transmitter shall be an NDIR (non dispersive infrared) type optical sensor. The optical reflectors and sensor shall be gold plated polymer. Optical bench shall be temperature compensated to ensure full range accuracy.

3. Sensor shall self-calibrates based on baseline concentrations measured during unoccupied periods and not require manual calibration over a minimum product rated life of 15 years.

4. Fully assembled (electronics, packaging and optical sensor) using ISO-9001 certified processes in an ISO-9001 certified manufacturing facility. Submit proof of ISO-9001 certification.

5. Provide EMI protection certification equivalent to EMC89/336/EEC.

6. CO2 measurement accuracy of ±1% of measured range + 3% of measured value (± 50 ppm at 1000 ppm). T90 response time of less than 2 minutes.

7. Operating range, 32 – 120 deg. F, 0-95% RH.

8. Output selectable 0-10Vdc or 4-20mA and a PC based RS-232 interface for customization of ranges or outputs.

9. Available with integral thermistor temperature transmitter to unit meeting requirements of 2.03.D.2 or 4 above (not 2.03.E).

10. Available in wall and duct mount versions with attractive and robust with screw locking polymer housings designed and listed for the application. Duct mounted version utilizes an aspiration box design utilizing a single probe that integrates both sampling and exhaust from the aspiration sampling chamber.

11. 24 month warrantee.

12. Design Make: Air Test Technologies, Inc. Model TR9220 / TR9221 and Honeywell/Vulcain model 90DM4.

G. Electronic Humidity Transmitter.

1. The electronic duct humidity transmitter shall sense duct humidity and shall transmit an electrical signal to the EMCS. A direct acting, proportional relationship shall be developed between the measured relative humidity and the transmitter output voltage,

2. Relative humidity shall be sensed by a cellulose acetate butyrate element and conveyed to a linear variable differential transformer. Changes in percent RH shall reposition the transformer core and create an imbalance in the secondary windings proportional to the magnitude of the RH sensed by the transmitter. The transmitter requires a +12 or +15 volt DC power supply. For a 10 to 100% RH input, the output shall be 0.5 to 5 volts with a +12 volt supply and 20 to 200 mV with a +15 volt supply. Change from one output range to the other shall be possible with a jumper.

3. The transmitter shall be provided with all electrical steel enclosure and cover; the element shall be protected with an aluminum guard.

    a. Action: Direct Acting, Proportional.
    b. Element: Cellulose Acetate; Butyrate-CAB.
    c. Operating Range: 10 to 100% RH.
    d. Supply Voltage: +12 volts DC, 60 mW (max.) or +15 volts supply -20 to 20 mV DC with a 15 volt supply.
    e. Output Signal: 0.5 to 5.0 volts DC with a 12 volt supply -20 to 20 Mv DC with a 15 volt supply.
    f. Load Resistance: 10k ohms with 0.5 to 5 volt output; 100k ohms with 20 to 200 Mv output.
    g. Accuracy: $\pm$ 2% of full scale (or RH) between 20 and 75% RH (includes non-linearity, hysteresis, and repeatability).
    h. Operating Environment: 40 to 125E F, 10 to 90% RH, non-condensing.

H. Temperature Sensors:

1. Temperature sensors shall be:

    a. Platinum wound RTD Type $\pm$ 1^{o}F. Factory calibration point - 70^{o}F at 1000 OHMS or 0^{o}C at 1000 OHMS. Adjustments for zero and span. Output 4-20 mA.

Or (for non averaging sensors)

    b. Contractor may use thermistors which are compatible with system as follows:

        1) Accurate to 0.35^{o}F over a range of -40^{o} to 240^{o}F,
        2) Noncalibrated devices, accuracy traceable to NBS testing,
        3) Guaranteed stability of 0.2^{o}F over a 15 year period,
        4) Interchangable with any other in the new system, and
        5) Shielded cable not require for the guaranteed performance.

2. Room element assemblies shall be located in conditions representative of the zone, on an interior wall where air is free to circulate around the element but away from non-representative air conditions such as drafts or heat radiation. Mount the assembly 5 feet above the floor on a standard electrical wallbox, or as otherwise directed or required to obtain satisfactory results. A mounting bracket, wallplate, decorative cover and tamper resistant screens shall be furnished with the assembly. May be S.S. wall plate type where applicable.

3. Outside air temperature sensing: The outside air sensor shall be mounted where the effects of sunlight and radiant heat are at a minimum (north wall) for true “dry-bulb” reading. Provide in enclosure to fit 1/2" threaded rigid conduit, designed for exterior dry-bulb sensing. Seal off fittings shall be used to prevent condensation on the element in the housing. Monitoring range to suit controls.

4. Duct temperature sensors: Duct insertion sensors for fan discharge and other thoroughly mixed applications designed for control and/or indication shall have a single sensor with an accuracy of 0.25% of scale range. Provide averaging type sensing elements for transmitters and capillary thermostats in mixed air and coil discharge applications to counteract effects of stratification. Length as required to provide at least four full passes across the duct – two long dimension and two diagonal. Capillary systems to be fully compensated. The element shall consist of nickel wire encased in a copper tube. Monitoring range to suit controls.

5. Liquid temperature sensors shall be mounted in separable brass immersion wells with 1/2" - 14 NPT threads, filled with "Insulgrease" or other approved heat transfer compound. Monitoring range to suit conditions. Well and spring loading device to assure RTD contact with end of sensing well. Whenever a sensing element and well are installed in a chilled water line, plumber's putty or some other suitable sealant shall be applied around the adapter as well as the point where the two sensors leads pass through the adapter. This is to prevent condensation of moisture in the well and failure of the element. Minimum well length to be equal to 1/2 of the pipe diameter; match bulb length to well length.

6. Battery powered “wireless communicating” sensors which use batteries as the source of power for transmission and communication of data are <u>not</u> acceptable.

2.12 HVAC PROCESS FLOW CONTROL COMPONENTS

A. Automatic Air Dampers (AAD on drawings):

1. Provide all automatic dampers except those specified as being furnished by equipment manufacturer. Automatic dampers are required at all exterior wall and roof openings serving a HVAC purpose which are provided or modified as a part of this project, whether or not called for on the drawings. Control dampers to operate with sequence described later or as directed.

2. Where damper is separating outside air from the conditioned space with no intervening air handler, for example relief air and exhaust fan dampers with short connected duct runs only, and additionally where called for on the drawings with the designation “TB AAD”, provide automatic dampers of thermally broken insulated construction design as described herein. Single thickness blades are permitted where they are in series with air handler dampers.

3. Size dampers at full duct or damper size indicated on the drawings, arranged for flanged to duct rather than inserted in duct installation (clear damper opening, <u>not</u> outside of frame, equal to duct size indicated). If neither duct or damper size is indicated; size for maximum velocity of 1500 fpm and maximum pressure drop including transitions to and from duct 0.05 in w.g.

4. Materials:

   a. General-service dampers not covered by the below restrictions, in galvanized steel ductwork, may be of galvanized steel construction.
   b. Dampers in aluminum ductwork: aluminum or stainless steel.
   c. Dampers subject to corrosive fumes: stainless steel of a type resistant to the fumes.

5. Overall Construction:

   a. Damper frames fabricated of extruded aluminum sections or formed steel, with reinforced corner bracing, suitable for flange mounting to duct. Seal any and all gaps at frame joints to maintain airtight integrity of ductwork.

      1) Where flanged to duct mounting is not possible due to space restrictions or where Owner prefers access from inside duct, propose slip in style dampers on a case by case basis in damper submittal along with individual rationale for frame style selection.

   b. Provide extruded aluminum airfoil construction for dampers modulating outside and return airflow, isolating lead/lag blowers, those operating on systems with over 2" water column potential close off pressure, and those operating over 1500 fpm.

   c. Fasten aluminum frames with approved stainless steel fasteners, separated from dissimilar metal casing by dielectric gasketing.

   d. Damper blades not more than 8" in width.

   e. Mount blades on electroplated square or hexagonal steel shafting operating in stainless steel, bronze, or approved polymer sleeve bearings.

   f. Provide corrosion resistant linkage and actuator mounting compatible with the damper materials and service, concealed in the frame outside of the airstream for flanged to duct applications and mounted in the airstream for slip in construction.

   g. Provide parallel blade operation for all two position dampers, and opposed blade operation for modulating dampers, with exception of face and bypass dampers which shall be made up of two sections of parallel blade dampers with the blades of one damper opposed to the blades of the other for proper mixing.

   h. Dampers over 48 in. in length and height shall be made into multiple sections.

   i. Dampers shall be capable of sequencing as required.

   j. Provide AMCA Standard 511 certified class 1A leakage dampers, with maximum leakage not exceeding 3 cfm per square foot at 1 inch water gage pressure differential, or 8 cfm per square foot at 4 inches water gage pressure differential when held in the closed position with a torque of no more than 6 inch pounds per sq. ft.

   k. Temperature range shall be suitable for the intended service.

6. Galvanized Formed Blade Construction Dampers:

    a. Frame of 16 gauge galvanized hat shaped channel.
    b. Blades of single thickness 16 gauge interlocking formed galvanized steel.
    c. Neoprene blade seals, and neoprene or compressible spring steel jamb seals.
    d. Design make: Arrow Series 395.

7. Extruded Aluminum Airfoil Construction Dampers:

    a. Frames and airfoil blades of extruded aluminum construction.
    b. Extruded polymer dampers seals with airstream inflatable double edges, mechanically locked in extruded blade slots, and easily field replaceable.
    c. Blades jamb seals compressible spring stainless steel.
    d. Design make: Ruskin Model CD-50 or equal.

8. Thermally Broken Design Dampers shall be of similar construction to Extruded Aluminum Airfoil Construction Dampers above, with the following modifications:

    a. Thermally broken frame with minimum three part extrusions separated by two structural urethane resin pockets.

    b. Blades constructed of two part airfoil aluminum extrusions thermally isolated by insulation, with blade cores filled with expanded urethane insulation.

    c. Dampers blade and jamb seals of extruded silicone and compressible spring stainless steel with leakage AMCA rated to -40 deg. F.

    d. Twin damper blade seals, one on either side of the thermal break, enclosing an insulating airgap.

    e. AMCA rated for energy efficiency with a minimum AMCA 500D Thermal Efficiency Ratio of 900%, and an assembly R value of 2 minimum.

    f. Design make: Tamco series 9000 BF, Ruskin Model TED50BF, Greenheck ICD45, or equal, all with options as required to meet specification.

B. Valves:

1. Valve Types:

    a. Ball valves – full port for two position on/off service, with characterizing disc for modulating service.
    b. Butterfly valves - two-position on/off service or for use in modulating service where specifically called out as such on drawings.
    c. Globe valves - modulating service.

2. Valve Bodies:

    a. Screwed bronze bodies (2" size and smaller).

    b. Flanged iron bodies (larger than 2" size).

c. Ball valves shall be of two piece full port stainless steel ball and stem design similar to those described in SECTION 23 05 23 but with reinforced actuator duty stems, adapters, and electronic actuators.

d. Butterfly valves shall be similar to those described in SECTION 23 05 23 with reinforced actuator duty stems, adapters, and actuators.

e. Globe valves shall have characteristic type throttling plug, #316 stainless steel or Monel stem, and removable composition seats, tight closing to class 4 standard minimum. Provided with necessary features to operate in sequence with other valves or damper operators and adjustable throttling range.

f. Two or three way as required.

g. Designed for 125 psi operating pressure.

h. Arrange to spring return to fail-safe position as called for, quiet operating.

3. Two position valves to be full line size unless otherwise indicated. Modulating water control valves shall be sized on the basis of the smaller of 15% of the total system pressure drop or 8 ft. of water column pressure drop, based on the system design flowrates. Include valve pressure drops in submittal for review. Tag each valve before delivery to project site with scheduled valve identification for location and service.

4. Provide valves and actuation so valves fail safe in normally open or closed positions as required to provide freeze, humidity, force, temperature, etc. protection. Fail position choice shall be submitted for review.

5. Select two-way modulating valves to have equal percentage characteristics.

6. Select three-way valves to have linear characteristics.

C. Actuators:

1. Electronic actuators:

a. Electronic actuators shall be motor driven with cast aluminum enclosure, with completely oil-immersed metal gear trains, sealed integral spiral spring return mechanism, force sensor safety stop, and shall have torque as needed to insure positive movement against system stall pressure. Furnish entire mechanism in housings designed for easy removal for service or adjustment.

b. Size each actuator motor to operate with sufficient reserve power to provide smooth modulating or 2-position action as specified.

c. Provide permanent split-capacitor, shaded pole, or synchronous motors with gear trains completely oil-immersed and sealed.

d. Equip motors for outdoor locations and for outside air intakes with "0 ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at -40 deg F (-40 deg C).

e. All actuators for exterior use shall be electronic style and shall have NEMA 4 enclosures with a rain shield covering the valve stem and entire actuator housing.

f. Damper actuators shall be direct-coupled over the damper shaft, and shall be installed without connecting linkage where possible.

    1) Where linkages are required, for example with multiple section dampers or dampers where actuator must be installed in the air-stream, provide with linkage furnished by the damper manufacturer and designed for the actuator being used.

g. Ball and Butterfly valve actuators shall be direct-coupled over the valve shaft, installed without connecting linkage.

    1) Globe valve actuators shall have a rack and pinion linkage provided by the valve manufacturer and designed for the actuator being used.

h. The actuator shall have electronic overload and digital rotation sensing to prevent damage to the actuator through the entire rotation range of the actuator.

i. Actuators shall be capable of both clockwise and counter clockwise motion by changing mounting orientation.

j. Provide proportional actuators for modulating services that accept a 0 to 10 VDC or 4 to 20mA control input and provide a 2 to 10 VDC or a 4 to 20mA operating range. An actuator capable of accepting a pulse width modulated / floating point control signal and providing full proportional operation is only acceptable for hydronic valve services where there is no connection to outside air.

k. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC power shall not require more than 11VA.

l. All actuators shall have an external manual gear release and actuators with more than 60 in-lb torque capacity shall have a manual crank to allow manual positioning when the actuator is not powered.

m. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

n. Actuators shall be provided with a conduit fitting and minimum three foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

o. Actuators shall be UL Standard 873 listed and CSA Class 4813 02 certified as meeting correct safety requirements.

p. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuators rated torque and shall have a minimum 2-year manufacturer's warranty, starting from the date of installation.

q. Design make: TAC-I/A *DuraDrive* series and Belimo models as required by torque.

2.13 SAFETY DEVICES

A. Low Limit: Electric type with 20' long serpentine element, coldest foot sensitivity, with automatic reset and auxiliary contacts to the EMCS. Set for 37 deg. F for "freeze" protection and 55°F for fan discharge application.

B. High Limit: Electric type, with manual reset; and auxiliary contacts to the EMCS, UL listed for fire, set for 125 deg. F.

C. Air Flow Switch: Electric, differential pressure type or equivalent.

D. Filter switches: Differential pressure type with adjustable set point, visual and audible trip indication, and auxiliary contacts to the EMCS.

E. Surge Suppression (Sp) Receptacle:

1. Surge suppression receptacle with metal oxide varister to dissipate the electrical energy of voltage spikes.
2. 20 ampere, duplex, NEMA 5-20R configuration.
3. Back and side wiring, high impact nylon body.
4. May be integral to panels.

2.14 MISCELLANEOUS DEVICES

A. Provide all necessary relays, controllers, accumulators, positioners, switches, solenoids, transformers, temperature sensors, and transducers for a complete system.

B. Locate these devices on local panel unless specified otherwise.

C. Wiring:

1. Controls power wiring: Provide wiring in accordance with requirements of Section 23 05 13 , Division 26, and the National Electrical Code.

2. Controls communications and data cabling:

a. Provide plenum rated cables, in full accordance with the requirements of Divisions 26 (Electrical) and 27 (Communication).

b. Provide cabling as recommended in writing by the controls manufacturer for optimized communications, similar to:

1) 22AWG single twisted pair, low capacitance (12.5pF/ft), shielded or unshielded plenum rated cable for low voltage communications.
2) 18AWG single twisted pair, low resistance (6mW/ft), shielded plenum rated cable.

3. Controls communications and data fiber optic cabling: Provide in accordance with the stricter of the requirements of Divisions 26, 27, and the written recommendations of the manufacturer of the equipment served.

4. Where additional wire to wire terminations are required beyond end device and controller termination strips, make connections using NEMA rated termination blocks with barrier isolated strip/screw or tube/screw connections, all labeled for current function. Flying splices not permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which materials and methods are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in acceptable manner.

1. Installation indicates conditions are acceptable to Contractor as required to ensure requirements for applicable warranty or guarantee can be satisfied.

2. Electrical Wiring: Check all electrical wiring associated with equipment for compliance with specifications and correctness of connections. Correct wiring in event equipment or devices fail to function in specified manner, whether due to incorrect connections or improper information and wiring diagrams.

3. Verify that conditioned power supply is available to control units and operator workstation as required.

3.2 WORK INCLUDED

A. Provide all labor, materials, equipment, and services required for the complete removal of all existing controls components being replaced or upgraded as a part of this project or which serve equipment being removed as a part of this contract.

1. Insure that controls for areas outside of this contract's work remain intact and functional. Report any existing problems with functionality before demolition. New problem areas not otherwise a part of this scope that result from this demolition work: rebuild original functionality or upgrade to be included in the new controls.

B. Provide all labor, materials, equipment, and services required for the complete EMCS installation, including Related Work, as required in the Contract Documents. Provide all programming labor required for creating the specified sequences of operation and associated graphics. Include labor required for integrating any software and programming enhancements made both during construction and commissioning and during the warrantee period. Include labor for any programming modifications required due to special circumstances not adequately described in the written sequences of operations, as required to control systems operation as intended.

C. Provide all controls wiring required to connect devices furnished as part of or adjunctive to this EMCS regardless of the source of supply. Provide connections to Owner's LAN, WAN, telephone, and internet as required to perform controls work. Coordinate all fiber optic, telecommunications, and other electrical connections with Owner.

D. Provide power wiring for controls requiring connection to AC power. Control circuits to be 120 vac maximum. Install wiring in accordance with requirements of SECTION 23 05 13 - COMMON ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT, Division 26, and the National Electrical Code. Provide actuator power wiring to all automatic dampers including fire/smoke dampers. Coordinate required relays, etc.. with fire alarm system control wiring by Division 28.

E. Provide all necessary devices required for proper system operation, including special electrical switches, conditioned power supplies, transformers, disconnect switches, relays, circuit breaker protection, as required.

F. Provide all controllers, actuators, sensors, etc. as specified later herein, and as required to meet the specified sequence of operation.

G. Furnish all valves, control wells, and dampers to Contractor responsible for their installation, as specified and as required to meet the sequence of operation.

H. Provide interface connections from EMCS hardware to equipment starting circuits, alarms, etc.

I. The system shall include all accessory equipment and electrical wiring to fulfill the intent of this specification, including all control and communications components required to interface with the Owner's Ethernet LAN, forming a complete and interoperable system.

J. Each portion of the District EMCS system as described above shall include all gateways, translators, interpreters, software, programming, or other accessory devices as required to achieve BACnet communications over the LAN.

3.3 INSTALLATION

A. System shall be installed and adjusted by trained mechanics and technicians, with a demonstrated experience of not less than (5) years, in the installation, adjustment, and repair of temperature control systems.

B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Components."

E. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

F. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

G. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.4 SYSTEM COMPONENTS

A. Current Transducer: As required; install per manufacturer's written instructions.

B. Static Pressure Transmitter: As required; install per manufacturer's written instructions.

C. Electronic Duct Humidity Transmitter: As required; install per manufacturer's written instructions.

D. Temperature Sensors: Install per manufacturer's written instructions, in locations representative of the controlled spaces' temperature as required for proper control. Include proposed sensor locations in wiring diagram submittal.

1. Provide room temperature sensors for all spaces where thermostats are not specifically called for, as required to properly and individually control all building mechanical HVAC and domestic hot water equipment in accordance with the sequence of operation. For large spaces, provide at least one room sensor per 2000 square feet, in locations representative of the room's various exposures and internal loads.

2. Temperature Sensor with Guard: Provide sensor with guard (preferably S.S. wall plate sensor) wherever temperature sensor is called for in publicly accessed spaces similar to corridors, vestibules, lobbies, stairwells, cafeteria, gymnasium, auditorium, etc..

3. Duct and pipe temperature sensors: Provide as shown on the controls schematics and as required to properly control per the written sequence of operations.

4. Outdoor air sensors: Provide as required to accurately sense outdoor air conditions for proper economizer control, at least five separate locations facing each of East, West, North, and South, as well as a representative rooftop location.

E. Automatic Dampers: Furnish dampers, tagged for proper location, (with multiple section damper linkages). Install per manufacturer's printed instructions. Adjust to close tightly. Allow for conduit sleeve or blank space for roof fan dampers.

F. Valves: Install with union or flanged connection. Locate close to apparatus controlled with pipe reducers and increasers located adjacent to valve. Locate, arrange, and pipe per installation diagram in an upright position (stem vertical).

G. Actuators: Install per manufacturer's printed instructions as to motor size and quantity, linkage arrangement, drive connection point. Where ducts or valves are insulated, set damper operators at least 2 in. away from equipment to allow for insulation.

H. Safety Devices:

1. Low Limit: Install on all equipment handling both water and any percentage of unheated outside air, including equipment in boiler rooms handling combustion air, serpentined on the discharge face of heating and/or cooling coils, or elsewhere as required for proper freeze protection, set at 37 deg F. Low limit trip shall report an alarm to the EMCS, which shall prevent the unit's fans from operating (not applicable to boiler burner fans), cause full flow of water in elements being protected, and fully close the outside air intake and exhaust air dampers until automatically reset (combustion air dampers shall not be closed when combustion is required for building heating). If some other sequence is required for proper freeze protection of special equipment or circumstances, provide this and detail in submittal.

2. High Limit: Install in the supply medium at the discharge of each fuel fired appliance. High limit trip shall report an alarm to the EMCS, which shall prevent the units burner from operating until manually reset.

3. Filter switches: Install across each bank of air filters in each air handling system.

4. Carbon Dioxide Sensor / Transmittor: Install in each space using demand control ventilation in the sequence of operations in location closely associated with breathing zone. If space is documented as having a fully mixed air space design and unit is designed to run 24 hrs/day, sensor may be duct mounted in return air.

I. Air Flow Stations: As required; install per manufacturer's written instructions.

J. Surge suppression (sp) receptacle: As required; install per manufacturer's written instructions.

K. Miscellaneous Devices: As required; install per manufacturer's written instructions.

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.6 SYSTEM SOFTWARE

A. Provide completely installed and ready for use.

B. System Configuration and Definition:

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete, or modify the following:

   a. SCUs.
   b. OWSs.
   c. UCs.
   d. Points of any type, and all associated point parameters and using constants.
   e. Alarm reporting definition for each point.
   f. Control loops.
   g. Energy management applications.
   h. Time and calendar based programming.
   i. Totalization for every point.
   j. Historical data trending for every point.
   k. Custom control processes.
   l. All graphic displays, symbols, and cross references to point data.
   m. Dial-up telecommunication definition.
   n. All operator passwords.
   o. Alarm messages.

3. System Definition/control Sequence Documentation: All portions of system definition shall be self documenting to provide hard copy printouts of all configuration and application data. Control process and EMCS control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequence to be easily interpreted and modified at any time in the future.

4. Database Save/Restore/Back-Up: Back-up copies of all standalone EMCS panel databases shall be stored in at least one personal computer operator workstation, and a secure electronic copy of the original complete database setup shall be stored at the offices of the TCS, available for the Owner's use.

5. Continuous supervision of the integrity of all EMCS panel databases shall be provided. In the event that any EMCS panel on the network experiences a loss of its databases for any reason, the system shall automatically download a new copy of the respective database to restore proper operations. Database back-up/download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of an EMCS panel database.

3.7 SCU PANEL LOCAL OR PORTABLE OPERATOR'S TERMINALS

A. Each EMCS panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.

1. There shall be a provision for both permanently mounting the standalone EMCS panel operator terminal, or using it as a portable hand held unit.

2. The EMCS panel operator terminal shall simultaneously display a minimum of 6 points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.

3. The operator functions provided by the EMCS panel operator terminal shall include, but not be limited to, the following:

   a. Start and stop points
   b. Modify setpoints
   c. Modify PID loop setpoints
   d. Override PID control
   e. Change time/date
   f. Add/modify start/stop weekly scheduling
   g. Add/modify setpoint weekly scheduling
   h. Enter temporary override schedules
   i. Define holiday schedules
   j. View analog limits
   k. Enter/modify analog warning limits
   l. Enter/modify analog alarm limits
   m. Enter/modify analog differentials
   n. Viewpoint history files

4. The EMCS panel operator terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any EMCS panel in the network.

5. Operator access at all EMCS panel operator terminals shall be identical to each other, as well as identical to the PC or Laptop operator workstations. Any password changes shall automatically be downloaded to all controllers on the network.

6. The EMCS operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats of point named. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.

7. A multifunction touch pad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the EMCS panel operator terminal shall change the limit touch pad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touch pad functions.

8. Context Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "Help" function shall provide general system operating instructions and specific descriptions of commands available in the currently displayed menus.

9. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be used to access points at the EMCS panel operator's terminal to eliminate cross reference or look up tables.

10. In addition to instantaneous summaries, the EMCS panel operator's terminal shall allow a user to view a point history file for system points. Point history files shall provide a record of value of analog points over the last 24 hours, at 30 minute intervals, or a record of the last ten status changes for binary type points.

3.8 GENERAL CONTROLS SYSTEM PROGRAMMING DESCRIPTION

A. Provide color graphic floor plan displays and system schematics detailing all mechanical and electrical systems as indicated in the sequence of operations, at least one for each system and piece of mechanical equipment, including air handling systems, chilled water systems, and heating systems. Create displays to represent logical grouping of system points or calculated data based upon building function, and mechanical system points which aid the operator in the analysis of the facility. The operator shall be able to view and control these systems via graphical and text-based displays and controls.

1. Provide access to the various system schematic and floor plan graphics via any and all of mouse driven graphical penetration scheme, menu selection, “file tree” organization, or text based commands.

a. Graphical menu penetration: locate and display systems graphics via a mouse driven procedure, designed and implemented to optimize performance analysis and speed alarm recognition. Five clicks maximum from whole district map to details of critical alarm via this route.

1) Whole District Map: Include each building shown as an active link; point and click to go to building. Display any building with (Owner defined, TCS implemented) alarms present as highlighted for rapid system review and diagnosis. Include at least three levels of alarm to facilitate prioritizing; each level shall be obvious and visually distinct. The most critical alarm in any building shall define the alarm level of that entire building in this graphic.

2) Main Building Display: Include a full floor key plan of each floor, broken into areas of detailed floor plans, with similar active point/click penetration scheme and highlighted alarm areas.

3) Detailed Floor Plans: Indicate the location of mechanical equipment (boilers, chiller, air handlers, duct and reheat / VAV systems, pumps and pumping systems, metering equip. etc.) and electrical equipment (switch gear, lighting, etc.) on the detailed floor plans. Highlight any systems when in alarm. Outline limits of each control zone (typically along walls, etc..) and provide active multicolored background for each zone. Zone background color shall change with space temperature deviation from setpoint, with a minimum of 8 background colors, colors to be distinct from alarm highlight colors.

4) System Specific Graphics: Provide pictorial schematically correct representations of each and every mechanical system controlled and/or monitored. Include all associated points, digital status, analog values, appropriate and/or significant calculated values, alarms, active adjustment of all user adjustable setpoints, links to all scheduling, trend logs, sequence of operations description, associated systems schematics in appropriate locations, etc. Include plain English descriptions of each active point / link shown. Include appropriate plain English warnings for alarms. Modify as required by Owner and Engineer during system review, start-up, and commissioning.

b. Menu and text based penetration: An operator request for information about a specific system shall cause the associated graphic display to be automatically selected and output on the viewing screen. The operator request may be entered via either the graphical menu penetration procedure or via a pull down directory tree style menu system with “specific building”, “specific mechanical room”, and “specific system” levels of identification. The pull down menu system shall cause the graphical menu system to be updated.

B. Graphic Representations

1. General: The program shall allow the operator to generate color graphics on-line using standard symbols selected from a standard library of symbols.

2. Provide customized graphics with dynamic point values and set points. Graphics shall include but not be limited to:

a. Each third party microprocessor controlled system with all points available.

b. Heating Hot Water System with heat injection systems, primary hot water system, secondary hot water systems, 3-ways, 2-ways, etc.

c. Air Handling Units, air and water sides, with coil pumps, zones, etc.

d. Floor Plans - The operator interface shall allow the user to access the various graphical schematics via a graphical penetration scheme of the floor plans. Minimum breakdown shall include:

1) Whole District map, showing all buildings.
2) Key plan of each building.
3) Floor plans of each building with zoom in capability.

C. Time Schedule Programs

1. The programs for the EMS shall schedule each system's operation on an hourly basis controlled through daily, weekly and/or monthly schedules. Schedules for each individual system, room or area shall be programmed and modified by the user on a calendar-like display at the OWS.

2. The programs shall store 60 months of schedules.

3. An internal time clock shall automatically compensate for daylight savings time and calendars generated by software shall automatically compensate for leap years.

D. Trend Logs:

1. Provide customized trend log reports with up to twenty variables per report for each HVAC system. Points shall be assignable at the OWS; coordinate desired points on each log with Owner during training and commissioning. Archive trended values on the system hard disk for future inquiry, with back up copies automatically prompted for and generated on removable media.

E. Alarm Points

1. All temperature inputs to the DDC system (space, return air, mixed air, discharge air, supply and return water, boiler and cooling systems) shall be alarmed at the host computer if the temperature is out of range 10 deg. F (adj.) above or below setpoint.

2. Fan status shall be monitored by analog current sensing devices or differential pressure switch. If the fan is scheduled to run and the status is not proven, an alarm condition shall be shown at the host computer.

3. Pump status shall be monitored by analog current sensing devices. If the pump is scheduled to run and the status is not proven, an alarm condition shall be shown at the host computer.

4. All alarm points of any stand alone controllers such as boiler burner controls, chiller or condensing unit controls, etc.., shall be monitored.

5. For all alarms, provide appropriate text and graphical annunciation to facilitate ease of understanding of source and location of problem. Coordinate annunciation with Engineer, equipment manufacturers, and Owner’s representatives.

F. Optimum Start Program

1. The building shall initially be brought to occupied temperature through an optimal start program. This program shall gradually increase space temperature requirements over a predetermined time to not only bring the building to required temperature but also soft start building mechanical equipment.

2. Each system shall have an independent modular program.

3. The program shall minimize the total energy consumption during daily start-up of each heating/cooling system.

4. A control algorithm shall compare the outside air temperature to space temperature and historical startup data to calculate a start time for each air handling system.

5. The start time for each system shall bring its respective zone to occupied setpoint at the time of occupied mode start.

6. The optimum start program shall be adjustable to the rate structure of the local energy company.

G. Optimum Stop Program

1. Each system shall have independent modular program.
2. The program shall minimize the total energy consumption during daily shut-down of each heating/cooling system.
3. A control algorithm shall compare the outside air temperature to space temperature to calculate a stop time for each air handling system.
4. The stop time for each system shall shut-down its respective zone as early as possible without letting the temperature drift out of the specified comfort range.
5. Minimum outside air ventilation shall be maintained where required by occupied status requirements of space served.

H. Smoke Dampers And Fire/Fan Shut Down

1. When fire alarm condition is initiated, the fire alarm system shall directly cause all fans 1000 cfm and larger to shut down and shall provide a signal to the EMCS to note fire alarm condition.

2. When fire alarm condition signal is received from the fire alarm system, initiate the following sequence:

   a. Cause all building fans 1000 cfm and larger to shut down. This is in addition to the direct shutdown caused by the fire alarm system.

      1) Allow variable speed drives to ramp down and ramp up on restart.

   b. Cause all smoke dampers and fire-smoke dampers to close and remain closed for the duration of the alarm condition. Delay closing smoke dampers until associated fan system has completely stopped (10 sec. Maximum).

   c. Do not permit unrelated HVAC equipment (heating valves, pumps, etc..) in building to lose control.

   d. Provide separate control wiring, connections to fire alarm system, all required smoke dampers, etc.., as required to accomplish the required sequence.

e. Upon termination of the fire alarm condition as indicated by a signal from the fire alarm system, cause all automatic fire/smoke dampers to open and prove open, then return all affected fans to their normally scheduled operation using the demand limiting staggered start algorithm.

I. Day/night Setback

1. The day/night setback will consist of lowering the space heating setpoint and raising the space cooling setpoint during the unoccupied mode, thereby reducing the heating and cooling energy requirements. The occupied and unoccupied areas will be specified by the owner and will be coordinated with the control system.

J. Economizer Cooling Cycle

1. The controls shall incorporate an enthalpy logic center with outdoor and return air temperature and humidity sensors that shall maximize the use of outdoor air for cooling before the mechanical cooling is energized and during operation through comparison of outdoor and return air enthalpy as follows. Note that multiple outdoor temperature conditions will be present at different outside air intake locations, and as such a comparable number of outside air sensors are required. Some mechanical systems may share a single outdoor air enthalpy center, for example adjacent UVs each facing east, providing the outdoor air conditions can be demonstrated to be virtually identical from an energy management perspective. Provide at minimum East, West, South, North, and Rooftop outdoor air sensors.

2. When the outdoor air enthalpy is less than the return air enthalpy during cooling mode, the logic circuitry shall cause the outdoor and return air dampers to modulate to the balanced outdoor air position that satisfies the critical space temperature transmitter set point before opening the system chilled water cooling valve.

3. If the outdoor air enthalpy is less than the return air enthalpy and the critical space temperature transmitter set point cannot be satisfied with 100% outside air, then the system shall circulate 100% outside air and the cooling water valve shall modulate open to satisfy the zone temperature requirements.

4. If the enthalpy sensors indicate that the return air has lower enthalpy than the outdoor air, then the system shall revert to normal cooling mode.

5. Upon a call for cooling to maintain the night setback temperature, only the economizer mode shall be operational. The chilled water control valve shall not be opened, and upon satisfying the space temperature transmitter night setback set point, the system shall revert to the normal unoccupied mode.

K. Maintenance Management: Continuously totalize run hours for equipment controlled and/or monitored for use by the maintenance management program.

L. Equipment Scheduling

1. Equipment shall be capable of 7 days, 24 hours schedules with separate holiday hours.
2. There shall be capability for five different holiday schedules which can be selected from the occupancy schedule graphic.

3. Holidays shall be programmed so that they shall need a minimum of manual adjustment year to year and can easily be modified at front end if necessary.
4. All schedule programming shall reside in local controllers, but shall be configurable from the front end.

M. Coil Freeze Protection.

1. Heating and cooling coils and any other equipment provided as a part of this project which are circulating water (not required for glycol coils) or are otherwise subject to water freeze damage, subject to the following, that have any percentage of unheated outside air entering them, shall have coil freeze protection.

2. Mixed outside and return air and the preconditioned discharge air from air to air energy recovery units shall be considered unheated for this purpose.

3. The first stage of coil freeze protection shall incorporate analog input temperature sensing at the expected freeze location. Sensing devices may be immersion style return water temperature sensor piped as close as practical to the outlet of the coil (within the rooftop unit if applicable), surface temperature sensors on the coil surface at the expected freeze location, or other comparable devices approved as applicable to the circumstances. Include details of freeze protection scheme for all such equipment in submittal. When the sensed temperature is above 60ºF (adj.), the coil control valve shall be under space temperature control. If at any time the expected freeze location sensed temperature drops below 60ºF (adj.), the control valve shall temporarily open to raise that coil's return water temperature to above 80ºF (adj.), and the EMCS shall report an alarm to the OWS

4. The second stage of coil freeze protection shall be the low limit freeze stat air temperature sensors with the sequence defined under safeties, above.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check instrument tubing for proper fittings, slope, material, and support.

5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

8. Check temperature instruments and material and length of sensing elements.

9. Check control valves. Verify that they are in correct direction.

10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.

11. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.10 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.

2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.11 SYSTEM TESTING AND COMMISSIONING

A. Test complete control system for control device operation prior to the systems acceptance. Demonstrate complete sequence of operations to Architect’s and Owner’s representatives.

1. Verify operation of system inputs and outputs, control loops and/or software programming, timing functions, operator entered constants, facilities management functions, etc., and observe that they perform their intended functions. Generate check out data sheets for each system so verified.

2. Field verify analog input calibration, analog output operation, digital input function, digital output operation, and coordination of system inputs and outputs between system graphics and field devices for schematic accuracy. Coordinate device testing with Testing and Balancing Agency – refer to Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC for additional information. Generate check list of all devices, keyed with descriptive locations and functions, along with complete calibration, testing, and coordination data, certified by Contractor and TAB agency.

3. Provide complete values and points logs, printed with hourly values for one week, demonstrating correct control functions and programming.

B. When above procedure has been completed and control systems are operating satisfactorily, produce and submit a report of entire systems performance for review, including all data described above. Submit three copies to the Architect's Representative advising them that the control system is 100% complete and operates in accordance with the Contract Documents.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, special-duty hydronic systems fittings, equipment, valves, and specialties, and joining methods for the following:

1. Hydronic Systems piping.
2. Blowdown and system drain piping.
3. Air conditioning condensate drain piping.
4. Air-vent piping.

B. Related Sections include the following:

1. Section 23 05 19 - Meters and Gauges for HVAC Systems.
2. Section 23 05 23 - General Duty Valves for Hydronic Piping.
3. Section 23 05 29 - Hangers and Supports for HVAC components.
4. Section 23 05 43 - Mechanical Vibration, and Movement Control.
5. Section 23 09 00 – Instrumentation and Control for HVAC.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Steel and Copper Hydronic Piping: 125psig at 250 deg F.
2. Vent and Drain Piping: Equal to the pressure and temperature of the piping system to which it is attached.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Above Grade Piping
2. Pipe Fittings.
3. Dielectric Fittings.
4. Specialty Valves.
5. Air and Pressure Control.
6. Pressure Control
7. Special Duty Hydronic Components.

B. Welding Quality Control Submittals

1. When welded or brazed pipe work is required or proposed as a part of this project, submit following for approval before beginning any welding or brazing work:

a. Welding and Brazing Procedure Qualification: Prepare and submit for approval welding and brazing procedure qualification specification qualifying all proposed procedures as specified in Quality Assurance below with copies of all back-up data.

b. Welders' and Brazers' Certification: Submit for approval certification that each proposed welder, welding operator, brazer, or brazing operator has been qualified in all procedures proposed for that worker as specified in Quality Assurance below with copies of all back-up data.

C. Qualification Data: For Mechanical Grooved and Pressure Sealed Joint Installers.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.
B. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with all applicable sections of the following:

1. ANSI / ASME B 31.9: "Building Services Piping".
2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
3. New York State Labor Department Industrial Code Rule No. 4 (cited as 12 NYCRR4)
4. New York State Labor Department Industrial Code Rule No. 14 (cited as 12 NYCRR14).
5. Building Code of New York State.
6. ANSI / ASHRAE 15 “Standard Safety Code for Mechanical Refrigeration”.
7. ASME label on all pressure vessels and safety valves.
8. ANSI / ASME B31 – “Code for Pressure Piping”.

B. Installer Qualifications:

1. Grooved Mechanical and Pressure Seal Joint Quality Control:

a. Installer Certification: Provide installers trained in and familiar with the installation of the mechanical joint systems, certified by the approved joint manufacturer as having been trained and qualified to join piping with manufacturer’s system.

b. Single Source: Obtain mechanically joined piping system components from single approved manufacturer for each system type, grooved or pressed.

c. Proper Tools: Fabricate and install joints using the proper tools, actuators, rolls, cutters, jaws, rings, etc., as manufactured and instructed by the approved manufacturer.

d. Manufacturer's Inspection: Certify grooved system installation for compliance with manufacturer's recommendations.

C. Welded Support Work Quality Control:

1. Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Welded Piping Work Quality Control:

1. Welding and Brazing Procedure Qualifications: Qualify any welding or brazing procedure to be used on this Project in accordance with ASME "Boiler and Pressure Vessel Code", Section IX. Qualification may by made by technically competent group or agency (subject to approval) meeting the following conditions:

a. Group or agency qualifying the procedure meets all procedure qualification requirements of ASME "Boiler and Pressure Vessel Code", Section IX.

b. Contractor accepts full responsibility for procedure qualified.

c. Contractor has qualified at least one welder or welding operator using procedure qualified and provides record of qualification.

d. Contractor accepts full responsibility for qualified procedures by signing related qualification records with procedure and performance qualifications including all dates, results, and associated data.

2. Welders' and Brazers' Qualifications: Ensure that all welders, welding operators, brazers, or brazing operators employed for this project are qualified for all welding and brazing procedures, proposed as part of this Project, in accordance with ASME "Boiler and Pressure Vessel Code", Section IX. Qualification by previous employer or technically competent group or agency (subject to approval) may be acceptable if following information is included:

a. Documentation that the previous qualification was for essentially the same procedures proposed and was in full accordance with ASME "Boiler and Pressure Vessel Code", Section IX.

b. Copy of performance qualification testing record showing who qualified the worker, date of qualification, and work history record showing continuous performance to maintain qualification.

3. Weld and Braze Qualification Records: Maintain and sign certified records of approved procedures used and approved qualified workers employed for welded and brazed joints performed as a part of Contract Work. Ensure all building services piping welding and brazing work can be traced to a specific procedure and welder.

4. Inspection and Examination by Owner, Remedy by Contractor: Owner reserves right to examine, inspect, and test all piping using visual, radiographic, or other recognized testing methods to determine compliance with specified quality control requirements and requirements of applicable regulatory agencies.

    a. Cost of Owner's testing of acceptable installation provided at Owner's expense
    b. Repair piping installations not passing Owner's quality inspection testing using approved method or replace at no additional cost.
    c. Cost of initial testing of piping not conforming to specified requirements and any retesting of repairs or replacement work shall be deducted from Contract Sum.

E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Refer to Part 3 for Piping Applications Article.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Anvil International, Inc.
2. Cerro Flow Products, Inc.
3. Mueller Industries, Inc.
4. S. P. Fittings; a division of Star Pipe Products.
5. Viega LLC
6. Victaulic Company of America.

C. Copper Tubing: ASTM B 88,Annealed or Drawn Temper, Types M, L, and K.

D. Copper Tube Fittings:

1. Solder Fittings

    a. Tees, Elbows, Reducers, Adapters: ANSI B16.22 streamlined pattern wrought copper or ANSI B16.18 cast bronze; solder end connections; ASTM B62.
    b. Unions: Solder type, cast bronze, ground joint, Class 150.
    c. Cast Bronze Flanges: ANSI B16.24 Class 150 solder connection flanges, raised ground face, ANSI pattern drilled and spot faced bolt holes.

2. Grooved-End Fittings and Couplings:

    a. Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
    b. Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves.

c. Gaskets: Prelubricated EPDM gasket manufactured by coupling manufacturer, rated for minimum 250 deg F for use with housing, and steel bolts and nuts.

3. Pressure-Seal Fittings:

a. Housing: Copper conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117.
b. Sealing elements: EPDM, factory installed by fitting manufacturer.
c. Leakage path designed into un-pressed fittings assuring readily visible leakage of system liquids past the sealing element of any un-pressed connection.
d. Tools: Manufacturer's special tools that compress fittings and effect pressure seal.
e. Minimum 200-psig working-pressure rating at 250 deg F.

4. Mechanically Formed Tee Option:

a. Outlet: formed by proprietary rotating tool expanding drilled side hole of main tube into precision collar.

b. Branch Inlet: Formed by proprietary tool that radius clips tube ends matching circumference of main tube, and dimples indicating correct insertion depth and orientation that remain visible after brazing.

c. Connection: Brazed joint, stronger than original main tube, with smoothly radiused branch entry and 0% flow obstruction.

2.2 STEEL PIPE AND FITTINGS

A. Refer to Part 3 for Piping Applications Article.

B. Steel Pipe: ASTM A53-S , A53-E, or A106 Schedule 40 or 80, seamless (type S) or electric-resistance welded (type ERW), Grade B, black or ASTM A123 and A153 galvanized steel pipe, plain or threaded ends.

C. Threaded Fittings:

1. Pipe threads in accordance with ANSI/ASME B1.20.1 National Pipe Thread taper (NPT) standards.
2. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.
3. Unions: ASME B16.39 malleable iron, threaded, Class 150 or higher, ground joint bronze to iron seat.
4. Cast-Iron Fittings: ASME B16.4; Class 125 or higher.
5. Malleable-Iron Fittings: ASME B16.3, Class 150 or higher.
6. Flanges: Cast Iron ASME B16.1 Class 125 or higher, raised ground face, ANSI pattern drilled and spot faced bolt holes.

D. Welded Steel Fittings: ASTM A 234/A 234M or A106 seamless forged steel.

1. ASME/ANSI B16.9 pattern with ASME/ANSI B16.25 beveled butt weld ends, wall thickness to match adjoining pipe.

    a. Long radius pattern unless space restrictions prohibit, then short radius allowed.

2. ASME B16.11 socket weld class 2000.

3. Flanges: ANSI B16.5 Class 150 or higher, butt weld neck type, raised ground face, ANSI pattern drilled and spot faced bolt holes.

4. Where branch connections are two or more sizes smaller than main size, "weldolets" or "threadolets" are acceptable.

5. Fabricate custom bend angle fittings by removing material from standard butt weld type fittings at the appropriate angle and recreating the original ASME B16.25 weld configuration chamfer.

    a. Shop or site-weld weld/groove adapter nipples to custom angle fitting where applicable to create custom angle grooved mechanical fittings.

E. Grooved Mechanical-Joint Fittings and Couplings:

1. All products – fittings, couplings, gaskets, and grooving tools - shall be manufactured by a single ISO 9001 or higher certified manufacturer.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
    c. Victaulic Company of America.

3. Mechanical Joint Fittings: ASTM A 536, Grade 65-45-12 Ductile Iron; ASTM A 47 Grade 32510 Malleable Iron; ASTM A 53, Types E or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings. Subject to applicable fitting requirements described elsewhere in this document. Basis of Design: Victaulic.

4. Mechanical Couplings: ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron split housing, designed for bolted assembly with full circumferential engagement of coupling into pipe end or fitting groove or alternatively to grip exterior of plain steel pipe where grooving is not possible. Coupling houses pressure responsive gasket by coupling manufacturer that forms durable pressure seal. Provide rigid type couplings for all straight runs and flexible type couplings for all branch takeoff (side of tee) and elbow fittings, unless otherwise specified or directed. Provide couplings with bolt size and strength and pressure rating not less than the listed product.

a. Grooved End Mechanical Flexible couplings: pad to pad coupling fit with clearance to groove. Basis of Design: Victaulic Style 77.

b. Rigid Grooved End Mechanical Couplings: full circumference coupling to groove compression contact for rigid style groove couplings. Basis of Design: Victaulic Style 07 and Style 107.

c. Rigid Plain End Mechanical Couplings: Extra heavy housing with hardened toothed jaws set into housing that engage and grip pipe exterior as bolts are tightened. Basis of Design: Victaulic Style 99 Roustabout.

5. Pipe End Grooves: Pipes may be delivered to site full length with factory grooved ends fabricated to coupling manufacturer's specifications or shop or site fabricated to length required using coupling manufacturer's groove cutting or rolling tool, fabricated to coupling manufacturer's specifications.

6. Coupling Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design manufacturer rated for fluid and temperature of service, minimum 300 psig working pressure at 250 degrees F.

2.3 JOINING MATERIALS

A. Flanges:

1. Gasket Materials:

a. ASME B16.21, nonmetallic, flat, asbestos free, suitable for chemical, pressure, and thermal conditions of system.
b. 1/8-inch maximum thickness unless thickness or specific material is indicated.
c. Full or narrow face pattern to fit flanges.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, electroplated, unless otherwise indicated.

3. Provide dielectric kit for flanges joining dis-similar piping materials.

B. Solder Filler Metals: Use solder conforming to ASTM B 32-95; alloy grades Sn96, Sn95, Sn94, E, AM, WS; lead free alloys with maximum lead content of 0.1percent by weight, minimum solidus temperature of 430 deg. F, and approved for use with potable water. Higher lead content solder not acceptable. Include water-flushable flux according to ASTM B 813.

C. Brazing Filler Metals: Select brazing filler metals compatible with piping to be joined:

1. AWS A5.8 BCuP Series, copper-phosphorus alloys for joining copper with copper only.

2. AWS A5.8 BAg series, cadmium free silver bearing alloys for joining dis-similar metals including copper with any brass, bronze, steel, or stainless steels, or other dis-similar brazeable materials.

D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials, designed to join dis-similar metallic piping materials with dis-similar metals separated by dielectric material in a configuration to minimize galvanic corrosion of the less noble piping material.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. Capitol Manufacturing Company.
3. Central Plastics Company.
4. Elster-Perfection Corporation.
5. Hart Industries International, Inc.
6. Lochinvar Corporation.
7. Pipeline Seal and Insulator, Inc.
8. Precision Plumbing Products, Inc.
9. Sioux Chief Manufacturing Company, Inc.
10. Victaulic Company of America.
11. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
12. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

C. All Materials: Suitable for system fluid, pressure, and temperature.

D. Dielectric Nipples:

1. Galvanized steel nipple with insert of noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

E. Dielectric Couplings:

1. Galvanized-steel coupling with insert of noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Unions:

1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

G. Dielectric-Flange Kits:

1. Flange assembly kit for field assembly. Include full-face or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, steel backing washers, and appropriately sized bolts and nuts. Provide higher strength bolts if undersized as required to maintain system working pressure.

2.5 VALVES

A. Isolation, Check, Balancing, Vent, and Drain Valves: Comply with requirements specified in Section 23 05 23 -General-Duty Valves for HVAC Piping

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 23 09 00 - Instrumentation and Control for HVAC.

2.6 HYDRONIC STRAINERS

A. Condensate Termination Strainers:

1. 1 inch NPT internally threaded inlet on corrosion resistant body of galvanized steel, stainless steel, or impact resistant plastic.
2. 10 mesh stainless steel screen outlet, formed or molded into body, with minimum 0.032 inch diameter wire and 4 square inches of screen.
3. Similar to TriTech Suction Filter QF053010A and Titan 710-046 Inlet Suction Strainer.

2.7 HYDRONIC PIPING ACCESSORIES

A. Pipe Sleeves:

1. Sleeve 6-Inches Diameter and Smaller: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A.

2. Sleeves Larger than 6-inches: Galvanized sheet metal, 10 gauge, round tube with welded longitudinal joint.

3. Sleeves Installed In Masonry Or Cold Formed Metal Framing/Gypsum Board Construction: Galvanized sheet metal, 20 gauge, round tube with welded longitudinal joint.

B. Escutcheons: Chrome plated, stamped steel, hinged, split-ring escutcheons, with setscrew. Inside diameter closely fits pipe outside diameter or outside diameter of pipe insulation where piping is insulated. Outside diameter completely covers opening in floor, wall, or ceiling.

1. Manufacturer: Manufacturers offering acceptable products include Grinnell.

C. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to fill annular space continuously between pipe and sleeve. Connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

1. Manufacturer: Manufacturers offering acceptable products include Thunderline Corp.

2.8 HYDRONIC PIPING SPECIALTIES SPECIFIED ELSEWHERE

A. Meters and Gauges: as specified in Section 23 05 19.
B. General Duty Valves: as specified in Section 23 05 23.
C. Hangers and Supports: as specified in Section 23 05 29.
D. Flexible Equipment Connectors: as specified in Section 23 05 43.
E. Pipe Thermal Expansion Compensation: as specified in Section 23 05 43.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Closed Loop Hydronic Piping (heating or dual temperature), aboveground, NPS 2 and smaller,:

1. Type L drawn-temper copper tubing with wrought-copper fittings, and soldered, pressure sealed, mechanically grooved, or brazed joints.

B. Closed Loop Hydronic Piping (heating or dual temperature), aboveground, NPS 2-1/2 and larger,:

1. Schedule 40 steel pipe with welded or mechanical grooved fittings and joints.

C. Air-Conditioning Condensate Gravity Drain Piping:

1. Type M or L, drawn-temper copper tubing, wrought-copper drain fittings, and soldered brazed pressure sealed joints.

D. Air-Conditioning Condensate Pressure-pumped Piping:

1. Type M or L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

F. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements were used to size piping, calculate friction loss, expansion compensation, pump sizing, fill volume, and other design considerations. Install piping generally as indicated unless deviations to layout are approved on Coordination Drawings.

B. Select system components with pressure rating equal to or greater than system operating pressure.

C. Install piping in concealed locations except in equipment rooms and service areas, unless otherwise indicated on drawings: install in walls, pipe chases, utility spaces, above ceilings, etc.

D. Install piping orthogonal to building walls as possible within constraints required for sloped drainage, non-orthogonal building construction, etc. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install fittings for changes in direction and branch connections, unless otherwise specified.

1. Branches two or more sizes smaller than main may be weld-o-let welded to steel pipe and brazed to copper using listed mechanically formed outlets similar to “T-drill”.

2. Minor offsets in copper fin-tube piping required to segment enclosures along curved exterior walls may be created by smooth bends in annealed type L or K copper tube. Do not bend fin element.

3. Mitered elbows, "shaped" nipples, and job fabricated reductions are not acceptable.

4. Where corridors or other general construction meets at angles other than standard pipe fitting angles, provide custom bend angle elbows to match general construction and maintain piping orthogonal to building.

F. Install piping so as to provide for positive drainage and air elimination.

1. Install straight piping free of sags and bends. Do not install bent piping – remove from site.

2. Install gravity drain lines at uniform slope down in direction of flow. Maintain maximum slope feasible up to one quarter inch rise per foot of run, but not less than 1% (approximately one eight inch per foot). Where height restrictions do not allow for minimum required slope, provide for pumped condensate removal as shown.

3. Install pressurized pumped flow piping at a uniform grade of 0.2 percent upward in direction of flow or at otherwise indicated slopes.

4. Avoid local high and low points where possible.

5. Install branch connections out the top of mains to serve equipment above mains, and out the bottom of mains to serve equipment below, or otherwise as required to provide drainage and venting with a minimum of drain and vent fittings.

6. Provide eccentric pipe size reducers and increasers, installed so as to allow for both positive drainage and air elimination. In general, where piping is sloped up in direction of flow, reduce pipe sizes with level side up and increase pipe sizes with level side down.

G. Install piping allowing for proper servicing of hydronic systems.

1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

2. Install piping and specialties with sufficient clearance to allow application of specified insulation.

3. Install valves with sufficient clearance and orientation to permit both ease of operation and servicing.

4. Install dis-assemble able unions, flanges, or mechanical joints on equipment side of isolation valve**,** as required to remove and service all serviceable components without system drain-down or cutting piping. Install unions and flanges in piping,.

a. Provide unions for NPS 2 and smaller, flanges for NPS 2-1/2" and larger.

b. Install adjacent to control valves, at final connections of equipment, as required to adjust threaded pipe joints after fixed (non-rotatable) joints are made, and elsewhere as indicated.

c. Install out of the line of coil pull, tube bundle removal access space, etc.

d. Install so sensor wires, thermometers, gauges, etc., need not be rotated, removed, or disconnected to service equipment.

e. Install within two feet of control valves with no elbows between valve and union as required for ease of replacement.

f. One dis-assemble able fitting may be used for two components (ex., both control valve and equipment service) if they are separated by no soldered, brazed, or welded elbows and no more than three feet of pipe.

H. Identify piping as specified in Section 23 05 53 - Identification for HVAC Components.

I. Install sleeves for piping penetrations of walls, ceilings, and floors.

J. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

K. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.3 PIPE JOINT CONSTRUCTION

A. General Pipe Joint Construction:

1. Cut all pipe ends square.
2. Ream ends of pipes and tubes removing burrs past original pipe wall to restore full pipe ID.
3. Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly.
4. Remake leaking joints using new materials.

B. Threaded Joints:

1. Provide threaded pipe ends in conformance with ANSI B1.20.1, tapered pipe thread standards

2. Cut threads full and clean using sharp cutting oil flooded dies.

3. Note internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine pipe threading and align threads at point of assembly.

4. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified) and assemble joint "wrench-tight" with paired wrenches, one wrench on adjacent pipe and one wrench on valve end where pipe is threaded.

5. Damaged Threads: Do not use pipe or fittings with torn, corroded or damaged threads.

6. Do not use portions of pipe where weld opens during cutting or threading operations.

C. Soldered Joints:

1. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook,"

2. Square cut tubing to correct length required to fill sockets.

3. Ream ends and clean surfaces of oils, grease, and oxidation to bright finish with fine sand cloth, cleaning pads, or special wire brush.

4. Apply thin film of solder flux to both surfaces to be joined. Do not clean, flux and assemble joint more than 3 hours before soldering, and do not use acid core, paste type solder, or solder flux combinations.

5. Remove heat-sensitive portions of components prior to soldering. Provide wet rag strip heat sink wrapped around stem and seat of valves and protect all components for soldering heat damage. Replace any components with any evidence of heat damage.

6. Heat joint uniformly and rapidly and fill completely with solder while minimizing external and internal over-soldered dripping.

7. Disassemble joints for inspection of solder penetration as directed. Remake faulty joints at no additional cost.

D. Brazed Joints:

1. Comply with the procedures contained in AWS "Brazing Manual", using qualified processes and brazing operators according to Part 1 "Quality Assurance" Article.
2. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
3. Fill the pipe and fittings with an inert gas (i.e. nitrogen or carbon dioxide) during brazing to prevent formation of scale.
4. Heat joints using oxyacetylene torch. Heat to proper and uniform temperature.
5. Completely fill sockets with braze materials and make neat fillets on butt joints.

E. Welded Joints:

1. Comply with the requirements of ASME Code B31.9 - "Building Services Piping", ASME B16.25, and AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

2. Machine-chamfer all pipe ends for butt welded joints.

3. Remove cutting beads and do not allow welding beads to form.

F. Grooved Joints:

1. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.

2. Assemble joints with coupling and gasket, lubricant, and bolts in accordance with fitting manufacturers written instructions.

3. Install rigid couplings for normal straight pipe runs.

4. Install flexible type couplings for branch take-offs, elbows, as part of the thermal expansion compensation system design, as vibration isolation flexible connections where specified for that, and as otherwise directed.

G. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application.

2. Install gasket concentrically positioned, and dielectric kits if flanges join dis-similar piping materials.

3. Align flanged surfaces parallel.

4. Use suitable lubricants on bolt threads.

5. Make initial contact of flanges and gaskets flat and parallel with bolts only finger tight, then tighten bolts using alternating sequential pattern, gradually and uniformly to full torque using torque wrench.

H. Mechanically Formed, Copper-Tube-Outlet Joints:

1. Use manufacturer-recommended tools and procedure.
2. Insure alignment dimples are properly oriented and visible after brazing.
3. Braze joints using approved procedures and brazers.

I. Pressure-Sealed Joints:

1. Make copper and copper alloy press connections in accordance with the manufacturer's installation instructions.
2. Fully insert the tubing into the fitting with a visible mark on the tubing showing proper insertion. Align the tubing as required.
3. Check the fitting alignment against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Leave insertion marks visible on pipe after assembly.
4. Press the joints using the tool(s) approved by the joint manufacturer in a manner to assure tubing remains properly aligned.
5. Remove and replace misaligned, kinked, or otherwise damaged tubing installations.

3.4 HYDRONIC SPECIALTIES INSTALLATION

A. At each system local or global low point, both in piping and heat transfer elements, and as required for complete system drainage, install drain consisting of a tee fitting and drain valve as described in Section 23 05 23 – General Duty Valves for HVAC Piping.

B. At each system local or global high point, both in piping and heat transfer elements, at the end of each horizontal run before a drop in elevation, and elsewhere as required for complete and serviceable venting of system air, install vent consisting of a tee fitting and air vent as described in Section 23 05 23 – General Duty Valves for HVAC Piping.

C. Install AC condensate termination strainers where AC condensate drips to any exterior point of indirect waste disposal.

D. Install all components of Energy Management and Control System (EMCS) into hydronic systems as required for complete EMCS installation and as required by this section maintaining integrity if hydronic systems. Coordinate all locations and quantities with contractor responsible for the EMCS – refer to Section 23 09 00 – Instrumentation and Control for HVAC.

1. Install control valves in accessible locations close to connected equipment or as otherwise shown, with dis-assemble able connections.
2. Install wells for pressure, temperature, and other sensors as shown on details and as called for by the sequence of operations.

E. Install ports and wells for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

F. Install pressure / temperature test ports (P/T plugs) at the supply and return of every heat transfer element, and as otherwise called for on drawings.

3.5 VALVE APPLICATIONS

A. Install General Duty Valves (isolation valves, check valves, balancing valves, air vent valves, and drain valves) as specified in section 23 05 23 – General Duty Valves for HVAC Piping.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 23 05 29 "Hangers and Supports for HVAC Components". Comply with the following requirements for maximum spacing of supports.

B. Sound, vibration, and movement control is specified in Section 23 05 43 – Mechanical Vibration and Movement Control.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size supply and return piping run-outs to equipment connections same as shown on the drawings. Where connecting to existing piping run-outs, use same size as existing unless shown otherwise. Transition to equipment connection size close to equipment. If equipment connection size is smaller than piping shown, transition to piping size shown immediately with no elbows (except reducer elbows) or other fittings closer to the equipment than the required transition fitting.

B. Provide for thermal movement of piping adjacent to terminal equipment, using flexible hose connections, swing joints, etc. Refer to Section 23 05 43 – Mechanical Vibration and Movement Control for details.

3.8 FIELD 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. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. 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.

5. 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. Isolate expansion tanks and 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 "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.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 22 13 – STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes

1. Steam heating piping systems including, but not limited to:

a. Steam supply and condensate return piping.
b. Steam and condensate piping specialties.

1.3 DEFINITIONS

A. Pipe Sizes: Where pipe sizes are specified in this Section, provide Nominal Pipe Sizes (NPS) unless otherwise specified.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Submit schedule of piping materials, service, fittings, specialties, and connections, along with full manufacturers' specification data.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with all applicable sections of the following:

1. ANSI / ASME B 31.9: "Building Services Piping".
2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
3. Building Code of New York State.
4. ASME label on all pressure vessels and safety valves.
5. ANSI / ASME B31 – "Code for Pressure Piping".

B. Inspection and Examination by Owner, Remedy by Contractor: Owner reserves right to examine, inspect, and test all piping using visual, radiographic, or other recognized testing methods to determine compliance with specified quality control requirements and requirements of applicable regulatory agency.

1. Cost of Owner's testing of acceptable installation provided at Owner's expense
2. Repair piping installations not passing Owner's quality inspection testing using approved method or replace at no additional cost.
3. Cost of initial testing of piping not conforming to specified requirements and any retesting of repairs or replacement work deducted from Contract Sum.

C. Single Source: Obtain grooved end piping and system components from same manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping

1. Provide factory-applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

2. Provide new pipe and fittings marked with manufacturer's name and complying with applicable ASTM and ANSI Standards.

B. Storage and Protection

1. Protect storage pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of floor.
2. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping and Tubing: Provide following types of pipe and tubing where indicated in the "Schedule Of Applications" specified in Part 3 below:

1. Hard Temper Copper Tubing: ASTM B 88, Type L.

2. Steel Pipe:

a. ASTM A53-S or A53-E, Schedule 40 or 80 (extra strong – XS) weight, seamless or electric-resistance welded (ERW), Grades A and B, black steel pipe, plain or threaded ends.

b. ASTM A53-S or A106; Schedule 40, seamless ASTM A153 galvanized steel pipe, plain or threaded ends.

B. Steel Pipe Fittings: Same pressure class as adjoining pipe minimum. Black or ASTM A153 galvanized; same as adjoining pipe.

1. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125 and 250, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

2. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150 and 300, standard pattern, for threaded joints. Threads shall conform to ANSI B.1.20.1.

3. Forged Steel Threaded Fittings: ANSI B16.11 forged steel; Class 2000 (Schedule 40).

4. Welded Steel Fittings:

   a. Materials

      1) ANSI B16.9 factory forged, seamless construction, butt weld type, chamfered ends; Schedule 40.
      2) ANSI B16.11 socket weld type, Class 2000 (Schedule 40).
      3) ASTM A 234, seamless or welded, for welded joints.

C. Where branch connections are two or more sizes smaller than main size, "weldolets", "threadolets", or "sockolets" are acceptable. Mitered elbows, "shaped" nipples, and job fabricated reductions not acceptable.

D. Fabricate custom bend angle fittings by removing material from standard butt weld type fittings at the appropriate angle and recreating the original weld configuration chamfer. Shop or site-weld weld/groove adapter nipples to custom angle fitting where applicable to create custom angle grooved mechanical fittings.

E. Unions: ANSI B16.39 malleable iron, Class 150, ground joint bronze to iron seat, for sizes 2 inch and smaller.

F. Flanges:

1. Cast Iron Threaded Flanges: ANSI B16.1 Class 125, raised face, boltholes spot faced.
2. Ductile Iron: ANSI B16.42; Class 150 and 300.
3. Steel Flanges: ANSI B16.5 Class 150, butt weld neck type, raised face, spot faced.

G. Gauge And Instrument Connections, Nipples and Plugs (for adapting gauges and instruments to piping system): IPS brass.

H. Copper Pipe Solder Fittings

1. Tees, Elbows, Reducers, Adapters: ANSI B16.22 streamlined pattern wrought copper or ANSI B16.18 cast bronze; solder end connections; ASTM B62.
2. Unions: 2 in. and smaller use unions, solder type, cast bronze, ground joint, Class 150.
3. Cast Bronze Flanges: 2-1/2 inch and over use ANSI B16.24 flanges, raised ground face, ASME drilled bolt holes spot faced, solder connection, Class 150.

I. Joining Materials

1. Solder For All Soldered Joints: Use solder conforming to ASTM B 32-95; alloy grades Sn96, Sn95, Sn94, E, AM, WS with maximum lead content of 0.1percent by weight, minimum solidus temperature of 430 deg. F, and approved for use with potable water. Higher lead content solder not acceptable.

2. Brazing Filler Metals: Select brazing filler metals compatible with piping to be joined:

a. AWS A5.8 BCuP Series, copper-phosphorus alloys for joining copper with copper only.

b. AWS A5.8 BAg series, cadmium free silver bearing alloys for joining dis-similar metals including copper with any brass, bronze, steel, or stainless steels, or other dis-similar brazeable materials.

3. Welding Filler Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code and AWS D10.12/D10.12M for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

4. Flanges:

a. Gasket Materials:

1) ASME/ANSI Standard (A21.11, B16.20, or B16.21), nonmetallic, flat, asbestos free, suitable for chemical, pressure, and thermal conditions of system.
2) 1/8-inch maximum thickness unless thickness or specific material is indicated.
3) Full or raised face pattern to fit flanges.

b. Provide dielectric kit for flanges joining dis-similar piping materials.

c. Manufacturer: "DURLON" as manufactured by Durabla Manufacturing Company, or equivalent.

2.2 STEAM PIPING SPECIALITIES

A. Flange Bolting Material

1. ASME B18.2.1, ASTM Specification A-107, carbon steel, electroplated, square bolt heads finished on the underside, semi- finished heavy pattern hexagonal nuts, US or SAE pattern grade 5 minimum washers.

B. Pipe Thread Compound

1. Crane, Dixon, Rutland or approved equal.
2. Use on metal threads only.
3. Do not use oil.

C. Dielectric Unions

1. Threaded or soldered end connections for the pipe materials in which installed.

2. Constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

3. Manufacturer:

a. Watts Regulator Co., or approved equal.

D. Dielectric Fittings

1. Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

2. Manufacturer:

    a. Epco Sales, Inc., or approved equal.

E. Steam and Condensate Strainers

1. General: Cast bronze high tensile body for use with copper piping. Ductile iron, ASTM A 126, Class B cast iron, or steel body for use with steel piping. Provide strainers in size indicated on drawings or same size as connected piping if not specifically indicated, with no higher pressure drop than the design make.

    a. Removable monel or stainless steel screen suitable for steam service:

        1) Strainers 3/4-inch diameter to 3-inches diameter: 1/32-inch perforations.
        2) Strainers 4-inches diameter to 6 inched diameter: 1/16-inch perforations.
        3) Strainers 8-inches diameter and larger: 1/8-inch perforations.

    b. Pipe Connections:

        1) 2-inch pipe and smaller: Screwed pipe connections.
        2) 2-1/2-inch pipe and larger: Flanged pipe connections.
        3) Soldered connections not permitted.

    c. Working Pressure Ratings: Same as fittings in lines where installed but not less than 125 PSI.

2. Y-Pattern Strainers:

    a. Tapped strainer blow-down cap, provide with full size capped ball valve.
    b. Threaded pressure taps in strainer body before and after strainer screen for connection to EMCS to alarm on excessive differential pressure.
    c. Design make: The Metraflex Company, Spirax Sarco, Watts, or approved equal.

F. Pipe sleeves

1. Schedule 40 galvanized, welded steel pipe, ASTM A53m Grade A, for sleeve 6" diameter and smaller.
2. Galvanized sheet metal, 10 gauge, round tube with welded longitudinal joint for sleeves larger than 6".

G. Mechanical sleeve seals

1. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Sleeve seals shall be connected with bolts and pressure plated which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2. Manufacturer: Thunderline Corp., or approved equal.

H. Escutcheons

1. Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw.

2. Inside diameter shall closely fit pipe outside diameter, or outside diameter of pipe insulation where piping is insulated. Outside diameter to completely cover the opening in the floor, wall, or ceiling.

3. Manufacturer: Grinnell or approved equal.

I. Traps

1. Capacities:

   a. Plans give normal operating condensing rate for each piece of equipment (MBH or EDR).
   b. Maximum pressure drop across trap not to exceed 1/2 psig at operating load.
   c. Determine maximum condensing rate by multiplying operating condensing rate by the following multiplier: 3.0.

2. Float and Thermostatic Traps:

   a. Body to be ASTM A 278, Class 30 cast iron body and bolted cap.
   b. Stainless steel float mechanism, with removable, hardened stainless steel head and seat.
   c. Balanced pressure thermostatic air vent made of stainless steel or monel bellows with stainless steel head and seat.
   d. Straight through pattern traps where necessary to gain extra headroom.
   e. Selected for low pressure service (0 to 15 psig).
   f. Manufacturer: Spirax Sarco or approved equal.

3. Thermostatic Traps:

   a. Body to be cast brass, angle pattern with integral union tailpiece and screw in cap.
   b. Balanced pressure stainless steel or monel diaphragm or bellows element, with removable hardened stainless steel valve head and seat.
   c. Selected for low pressure service (0 to 15 psig).
   d. Manufacturer: Spirax Sarco or approved equal.

J. Vacuum breakers

1. Brass body, seat, stem, and cap. Maximum operating pressure rating to be 150 psig.
2. Stainless steel spring with adjustable settings (1/4 to 20 inches).
3. Manufacturer: Hoffman No. 62 or approved equal.

K. Air vents

1. Quick Vents: Cast iron or brass body, with balanced pressure, stainless steel or monel thermostatic bellows and hardened stainless steel heads and seats. Use quick vents to eliminate air from steam mains if only steam and air are present.

   a. Design make: Spirax Sarco model T202, Hoffman #4, or approved equal.

2. Float Vents: Cast iron or brass body, seamless brass float, balanced pressure thermostatic bellows, and replaceable stainless steel seat, float, and head.

   a. Design make: Hoffman model 4-A or approved equal.

3. High Capacity Float Vents: Cast iron or brass body, seamless brass float, balanced pressure thermostatic bellows, and replaceable stainless steel seat, float, and head.

    a. Design make: Hoffman model 75 or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which heating piping is to be installed and notify affected Contractors and Engineer in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When conditions are confirmed to be acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Engineer written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable.

3.2 INSTALLATION

A. Steam Piping Installation: Drawings (plans, schematics, details, and diagrams) indicate the general location and arrangement of piping systems. However, they are not intended to show every required offset, fitting, or component required either to fit the intended space or to meet all requirements of this specification. Locations and arrangements of piping take into consideration piping sizing and friction loss, air and pressure control, thermal expansion, pump sizing, and other design considerations. Install piping as indicated as far as practical.

1. Use fittings for all changes in direction and all branch connections, unless otherwise specified.

2. Install piping close to slabs, beams, joints, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

3. Steam and condensate piping slopes:

    a. Provide consistently sloped straight runs with no dips and partial traps.
    b. 2-pipe system steam supply piping: ¼” in ten feet down in the direction of flow.
    c. 2-pipe system condensate return piping: ¼” in ten feet down in the direction of flow.

4. Make reduction in pipe size using eccentric reducer fittings installed with the level side at bottom of pipe.

5. Do Not:

    a. Run within 6 inches of finished floors.
    b. Run across windows without Engineer’s approval.

c. Run with less than head clearance without written approval of Engineer.
d. Use bent pipe, unnecessary joints, and short length.
e. Use reducing bushings, close nipples.
f. Use unnecessary unions or joints in concealed piping or allow air pockets to be left in line.
g. Spring or force pipe into position.
h. Use bull headed tees.
i. Use mitered bends or notched pipes.

B. Pipe Joint Construction: Cut all pipe ends square, ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe. Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly. Remake leaking joints using new materials.

1. Soldered Joints:

a. Cut tubing to exact lengths with a square cut. Properly ream end of tubing to remove all burrs. Clean surfaces of oils, grease, and oxidation and clean with fine sand cloth, cleaning pads, or special wire brush.

b. Apply thin film of solder flux to surfaces to be joined. Do not clean, flux and assemble joint more than 3 hours before soldering, and do not use acid core, paste type solder, or solder flux combinations.

c. Disassemble joints for inspection of solder penetration as directed.

d. Follow manufacturer's instructions for joining copper tubes and solder cup valves.

2. Brazed Joints: Comply with the procedures contained in AWS "Brazing Manual".

a. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
b. Fill the pipe and fittings during brazing, with an inert gas (i.e. nitrogen or carbon dioxide) to prevent formation of scale.
c. Heat joints using oxyacetylene torch. Heat to proper and uniform temperature.

3. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

a. Note internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine pipe threading and align threads at point of assembly. .

b. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified) and assemble joint “wrench-tight” with wrench on valve on the valve end where pipe is threaded.

c. Damaged Threads: Do not use pipe with corroded or damaged threads. Do not use portions of pipe where weld opens during cutting or threading operations.

4. Welded Joints: Comply with the requirements of ASME Code B31.9 - "Building Services Piping".

a. Use welded fittings, flanges, and V-butt welded joints and machine-chamfer all pipe ends.

b. Remove cutting beads and do not allow welding beads to form.

c. Do not use mitered bends. Make all changes in direction with long radius fittings, unless space restrictions prohibit long radius fittings.

d. Make all branch connection with tees, unless otherwise specified. Branches two or more pipe sizes smaller than main may be welded directly to mains using approved qualified procedure with either Weldolets or shaped nipples.

5. Flanged Joints: Aligned flanged surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets flat and parallel. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.3 PIPING SPECIALTIES INSTALLATION

A. Install in accordance with manufacturer's recommendations and instructions.

B. Dielectric Unions:

1. Install at all connections of dissimilar metals, except where bronze or brass body fittings separate dissimilar piping. (Contractors option of using dielectric unions or fittings).

C. Dielectric Fittings:

1. Install at all connections of dissimilar metals, except where bronze or brass body fittings separate dissimilar piping. (Contractors option of using dielectric unions of fittings).

D. Pipe Line Strainers:

1. Install strainers on the supply side of each control valve, pressure reducing valve, solenoid valve, inline pump, and elsewhere as indicated.
2. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

E. Pipe Sleeves:

1. Provide pipe sleeves for all piping penetrations of masonry walls and floors.

a. Provide light gauge sheet metal sleeves for all penetrations of masonry block partitions.

b. Provide schedule 40 pipe and 10 gauge sheet metal sleeves for penetrations of poured masonry walls and floors.

c. Set sleeve 1/2" above finished floor for all piping passing through toilet rooms, kitchens, equipment rooms, and rooms where the floor may be wet during normal maintenance.

d. For existing construction, bore round holes 1/2" larger than pipe outside diameter for uninsulated piping, and 1/2" larger than insulation outside diameter for insulated piping. Sleeves are not required for bored holes except where required for waterproofing as specified above.

2. Caulk annular space between pipe and sleeve with Silicone Elastomer Compound (Dow Corning Fire Stop Sealant Catalog #2000) at all penetrations of fire rated walls and floors.

3. Do not cut reinforcing rods.

F. Mechanical Sleeve Seals:

1. Provide seals at all penetrations of exterior walls and at sleeves installed in wet areas (kitchens, toilet rooms, equipment rooms, etc).

G. Escutcheons:

1. Provide escutcheons for all piping penetrations of walls, floors and ceilings exposed to view.

H. Steam Traps:

1. Install steam traps in accessible locations as close as possible to connected equipment. Maximum allowable distance from equipment is 4 feet.
2. Install float and thermostatic traps for all coils tempering outdoor air, unit heaters, heat exchangers, and drip traps.
3. Install thermostatic traps for radiation and convectors.

I. Vacuum Breakers:

1. Install in piping between automatic control valve and steam trap where noted on Drawings.

J. Air Vents:

1. Install air vents in accessible but concealed locations as close as possible to connected equipment. Install where shown on drawings and as required to insure rapid and consistent venting of air from steam lines on start-up.

2. Provide high capacity venting at end of mains, and normal capacity vents for runnouts unless otherwise shown.

3.4 FIELD QUALITY CONTROL

A. Testing Preparation

1. Steam and Condensate Piping: Comply with ASME B31.9 and as follows:

a. Leave all joints un-insulated and exposed for examination during test.

b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restrainers are not practical, isolate expansion joints from testing.

c. Flush system with clean water. Clean strainer.

d. Isolate equipment not subjected to test pressure from piping. If valve is used to isolate equipment, provide closure capable of sealing against test pressure without damage to valve. Testing not required on flanged joints where blinds are inserted to isolate equipment.

e. Install relief valve set at pressure no more than 1/3 higher than test pressure to protect against damage by expansion of liquid or other source of overpressure during test.

B. Testing: Test piping and accessories before insulation, connection to existing piping, or concealment. Repeat as many times as necessary to prove tight system. Notify Owner's Representative and Engineer at least seven days in advance of each test. Isolate valves and equipment not capable of withstanding test pressures. Make systems leak free; no caulking permitted. Remove and replace defective fittings, pipe or connections. Furnish necessary pumps, gauges, equipment, piping, valving, power, and labor for testing. Certify that tests have been successfully completed.

C. Schedule of Test Requirements:

1. Steam and Condensate Systems: Perform hydrostatic test at 100 psig at high point of system; two hours duration with no change in pressure under stable temperature conditions. Verify that entire system(s) are leak free without drips or weeps.

2. Equipment: Test at working pressures.

3.5 SCHEDULE OF APPLICATIONS

A. Piping types and joint styles may be mixed within a system within the scope of the requirements of this Section.
B. Steel steam supply pipe shall be schedule 40 or schedule 80. Condensate return pipe, including low wet condensate return, shall be schedule 80.
C. Steel pipe with threaded joints and fittings: Above ground, within building, for sizes 2" and smaller. Steel steam and condensate pipe with threaded joints shall be schedule 80.
D. Steel pipe with cut or rolled grooved ends and mechanical couplings and fittings are not approved for use on steam or steam condensate piping systems.
E. Type L hard temper drawn copper tubing with wrought copper fittings and brazed joints: for 2” and smaller steam and steam condensate, above ground, within building.
F. Type L hard temper drawn copper tubing with wrought copper fittings and soldered joints: for 2” and smaller pressurized pumped condensate services, above ground, within building.

END OF SECTION 23 22 13

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of refrigerant, piping, valve, and refrigerant piping specialty proposed. Include pressure drop, based on manufacturer's test data, for the following:

1. Refrigerant.
2. Thermostatic expansion valves.
3. Solenoid valves.
4. Hot-gas bypass valves.
5. Filter dryers.
6. Strainers.
7. Pressure-regulating valves.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.
B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type KASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inchmisalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.

4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Check Valves:

1. Body: Forged brass, or cast bronze; globe pattern.
2. Bonnet: Forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. End Connections: Socket, union, threaded, or flanged.
6. Maximum Opening Pressure: 0.50 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight, replaceable AC coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and voltage as required.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Include Manual operator.

E. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

F. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight, replaceable AC coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and voltage as required.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.
12. Include manual operator.

G. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

H. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

I. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

J. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.

4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

K. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.

L. Receivers: Comply with ARI 495.

1. Comply with UL 207; listed and labeled by an NRTL.
2. Body: Welded steel with corrosion-resistant coating.
3. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
4. End Connections: Socket or threaded.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 4and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR or K, drawn-temper tubing and wrought-copper fittings with soldered joints.
B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR or K, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. 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.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. 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.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. 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.

G. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Thermostatic expansion valves.
2. Hot-gas bypass valves.
3. Compressor.

H. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor, if not provided as part of installed equipment manufacturer.

I. Install receivers sized to accommodate pump-down charge.

J. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. 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.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Section "Instrumentation and Control for HVAC" and sequences of operations shown on drawings for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. 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 Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Liquid lines may be installed level.

O. 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.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in specification Section 23 05 29 - Hangers and Supports for HVAC Components.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feetlong.
2. Roller hangers and spring hangers for individual horizontal runs 20 feetor longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feetor longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. 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 Part 1 "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.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

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:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.

5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 31 00 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sheet metal duct materials and construction.
2. Sheet metal duct fittings materials and construction.
3. Flexible duct and connectors.
4. Ductwork ancillary components materials and construction.

B. Related Sections

1. Section 23 05 29 – Hangers and Supports for HVAC Components.
2. Section 23 05 43 – Mechanical Vibration and Movement Control.
3. Section 23 07 00 – HVAC Insulation.
4. Section 23 37 00 - Air Outlets and Inlets.
5. Division 23 sections covering fans and air handling equipment.

1.3 DEFINITIONS

A. Aspect Ratio: The ratio of duct width to height.

B. Hydraulic Radius: The ratio of duct cross section area to perimeter, or practically, a term used to define flow resistance of duct with differing aspect ratios, with resistance to flow being approximately proportional to hydraulic radius.

C. NRC: Noise Reduction Criteria

D. Offset: A change in the duct centerline location but not direction occurring within one piece of duct.

E. RGD: Registers, Grilles, and/or Diffusers

F. STC: Sound Transmission Class

1.4 PERFORMANCE REQUIREMENTS

A. Provide duct system able to withstand the loads and stresses described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and these contract documents.

B. Fabricate outdoor duct and casings to withstand wind load and snow load indicated on Structural series drawings and specifications. Calculate the snow load as a negative pressure on the top duct surface.

C. Fabricate ductwork able to withstand the forces imposed by the support and restraint system.

1.5 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Identify in writing, any proposed deviations from contract Drawings and Specifications.

1. Highlight all changes from plans required by obstructions and job conditions.

2. Bring any proposed deviations from contract plans and specifications to Architect's attention in writing, by separate letter attached to submittal with proposed deviations, along with samples for clarification, demonstrating benefit to Owner.

C. Product Data: Submit for approval annotated Shop Construction Standards showing upgrades as required for conformance in detail to specifications for all factory and shop fabricated air ducts, components, and accessories.

D. Shop Drawings:

1. Prepare and submit 1/4" = 1’ scale or larger shop drawings for all areas within 30 days after contract award unless Architect, Construction Manager, and Owner agree in writing upon another shop drawing schedule. Refer to section 01 33 00 – Submittals for additional information.

   a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   b. Factory- and shop-fabricated ducts and fittings.
   c. Duct layout indicating sizes, configuration, liner material, and SMACNA pressure class required for all duct.
   d. Indicate duct elevation above floor (top and bottom of ducts), bottom of structure especially at critical passages, and ceiling height for each room.
   e. Dimensions of main duct runs from building grid lines.
   f. Fittings.
   g. Reinforcement and spacing.
   h. Seam and joint construction.
   i. Penetrations through fire-rated and other partitions.
   j. Equipment installation based on equipment being used on Project.
   k. Indicate locations and sizes of all dampers, turning vanes, access doors and panels, and other required accessories.
   l. Hangers and supports, including methods for duct and building attachment and vibration isolation.

E. Welding certificates for duct welders. Refer to section 23 05 00 – Common Work Results for HVAC for detailed requirements.

1.6 CLOSEOUT SUBMITTALS

A. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00 – Closeout Procedures, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

B. Field quality-control reports – duct leakage, duct cleanliness.

1.7 QUALITY ASSURANCE

A. Provide ductwork by experienced and approved workers specializing in sheet metal fabrication and installation in accordance with the stricter of the below referenced standards and the requirements outlined in these contract documents.

B. Referenced Standards

1. The latest editions of the publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

2. American Society of Civil Engineers (ASCE):

   a. ASCE7 Minimum Design Loads for Buildings and Other Structures

3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

   a. ASHRAE / ANSI 62.1 – Ventilation for Acceptable Indoor Air Quality.
   b. ASHRAE / ANSI 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

4. American Welding Society (AWS)

   a. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
   b. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports.
   c. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

5. American Society for Testing and Materials (ASTM):

   a. A167 99 Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip
   b. A653-09 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
   c. A1011-09a 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
   d. B209 07 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
   e. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
   f. D6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

g. D7803 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating
h. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials

6. National Fire Protection Association (NFPA):

a. 90A Standard for the Installation of Air Conditioning and Ventilating Systems

7. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

a. HVAC Duct Construction Standards, Metal and Flexible
b. HVAC Air Duct Leakage Test Manual

8. Underwriters Laboratories, Inc. (UL):

a. 181 Factory Made Air Ducts and Air Connectors

PART 2 - PRODUCTS

2.1 DUCT MATERIALS

A. General Material Requirements:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.

2. Provide sheet metals per mill specs and free of pits, voids, seam or roller marks, stains, discolorations, inadvertent bends and kinks, and other imperfections.

B. Standard Supply, Return and Exhaust: Galvanized steel, ASTM A-653/653M G90, lock forming quality, unless otherwise specified.

C. Standard Supply, Return and Exhaust duct which will be exposed to view in the finished project and will not be externally insulated or painted: Galvannealed steel, ASTM A-653/653M G90, lock forming quality, unless otherwise noted.

D. Standard Supply, Return and Exhaust duct which will be exposed to view in the finished project and will be painted: Galvannealed steel, ASTM A-653/653M G90, lock forming quality, prepared for painting via mill phosphatizing and subsequent heat treatment in accordance with ASTM D6386 and ASTM D7803 as applicable, unless otherwise noted.

E. Coatings:

1. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

a. Galvanized Coating Designation: G90.

b. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.

c. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

F. Flexible Ducts:

1. Flexible Duct (standard ventilation air register, grille, and diffuser connections where noted on Drawings. Maximum installed length to be 5'-0"): Medium pressure CPE or polymeric coated woven fiberglass cloth liner, enclosed spring steel wire, R-6 fiberglass insulation covered by metalized polyester film bi-directionally reinforced vapor barrier. Similar to types S-TL (uninsulated for field insulation), M-KE, or M-KC, with FlexFlow elbow supports, all by Thermaflex (design make).

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials, and use stainless steel fasteners.

2.2 RECTANGULAR DUCTS AND FITTINGS

A. Conform to appropriate SMACNA rectangular duct reinforcement tables and figures for the velocity-pressure classification duct construction required as defined in part three of this document, and additionally as follows.

1. Seal all joints and seams in accordance with SMACNA seal classification required for duct in question.

a. Additionally, seal field assembled longitudinal seams for seal class B duct.

2. Transverse Joints: in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure for "Rectangular Duct/Transverse Joints".

a. For all duct requiring reinforcement, provide SMACNA T-24 or T-25 type flanged duct connection system at traverse joints.

1) Joints may be factory manufactured slip on type or integrally shop fabricated onto the duct sheet metal on machinery designed for that purpose. Corner closure pieces are required at each corner.

2) Manufacturers: Subject to compliance with requirements, available manufacturers offering pre-manufactured slip on reinforcement products that may be incorporated into the Work include, but are not limited to, the following:

a) Ductmate Industries, Inc, or equal.

b) Lockformer TDC or equal.
c) Nexus PDQ type G or J or equal.

3. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

4. Tie rods are not permitted on duct or plenums narrower than 72". Where an option for tie rod or heavier gauge sheet metal / shorter joint length / higher category reinforcement is presented in table, the heavier, shorter, more reinforced duct with no tie rods is required.

B. Offsets:

1. Where offset dimension is equal to or less than 0.2 times duct dimension in plane of offset, offset may be angled at maximum 15 degrees (SMACNA type 1).

2. Where offset dimension is greater than 0.2 times duct dimension in plane of offset (example: 10 x 20 duct offset in plane of 10" dimension greater than 2 inches), offset to consist of paired curved elbows, each of the required angle, combined into one fitting (SMACNA type 3).

a. Conform to elbow requirements as indicated below.
b. Offset may be replaced with paired curved elbows if required for installation, otherwise provide combined fitting.

C. Transitions of shape or cross section:

1. Reductions in cross section shall have a maximum included cone angle of 60 deg., with a maximum single side angle of 45 deg. from axial, unless otherwise specified in writing.

2. Transformations of section without a net reduction of cross section shall have no section of reduced hydraulic radius nor any local expansion of more than 15 deg. net included cone angle, as defined by ASHRAE and SMACNA.

3. Expansion sections, unless specifically drawn and noted otherwise, shall have:

a. No section of reduced hydraulic radius
b. No section of local expansion of more than 15 deg. net included cone angle.
c. No single side expansion angle of more than 15 deg. from axial unless otherwise specified in writing.

D. Elbows:

1. Make all changes in direction (as opposed to offsets above where direction remains the same) regardless of angle with elbow fittings unless specifically drawn and noted otherwise.

2. Curved Rectangular Elbows:

   a. Along critical pressure drop paths, provide curved rectangular elbows.

      1) Critical pressure drop paths shall be as indicated on drawings or if not indicated shall be considered to be entire duct run from air handling unit along mains to or from furthest terminal. Systems with more than one main branch shall be considered to have more than one critical pressure drop path.

      2) Provide critical path elbows with throat radius not less than dimension of duct in plane of radius or use smaller inner radius elbows with splitter vanes such that the ratio of inner to outer radius of curvature of any section of the elbow shall not be less than 1/2.

   b. Along non-critical pressure drop paths, curved rectangular elbow radius requirements may be relaxed to a throat radius not less than one half the dimension of the duct in plane of radius or use smaller inner radius with splitter vanes such that the ratio of inner to outer radius of curvature of any section of the elbow shall not be less than 1/3.

   c. Construct all curved elbows of increasing or decreasing cross section in accordance with critical pressure drop path criteria.

   d. Fabricate splitter vanes per SMACNA Duct Manual construction standards.

3. Mitered rectangular elbows

   a. Only elbows not along critical pressure drop path may be of curved or mitered construction.
   b. Mitered rectangular elbows with angle of bend under 15 deg. may have miter at duct end similar to SMACNA type 1 offset.
   c. Provide turning vanes in mitered rectangular elbows with angle of bend over 15 degrees.
   d. Mitered elbows with angle of bend over 100 deg. or less than 80 deg. shall not use commercially available 90 deg. turning vanes

4. Double Wall Turning Vanes

   a. Provide for mitered rectangular elbows of equal inlet and outlet or increasing cross section

   b. Blades of hollow double wall construction, with smaller radius sheet metal form nested outside larger radius form, tapering down gradually to and welded at double thickness edge, designed for specific spacing and alignment to minimize separation of flow and pressure drop through air duct elbows.

   c. Properly spaced to result in constant cross-section area between blades: smaller radius blades to have closer spacing

   d. Maximum spacing 3 inch, unless otherwise approved.

   e. Acoustical type where called for or where installed in acoustically lined ductwork.

f. Provide products by one of the following:

1) Titus or equal
2) Elgen or equal
3) Hardcast or equal.

5. Single Wall Turning Vanes

a. Provide in mitered rectangular elbows of increasing or decreasing cross section and those with a turning angle greater than 100 degrees or less than 80 degrees.

b. Blades of single wall 16 gauge construction with leading and trailing edges aligned to the direction of flow, installed per SMACNA Duct Manual standards so as to provide smooth area transition. Maximum spacing 3 inch, unless otherwise approved.

E. Duct Branches:

1. Install branches, inlets, and outlets so that air turbulence is reduced to a minimum and air volume properly apportioned. Install airflow adjustment devices at all junctions to permit adjustment of the amount of air entering or leaving the branch.

2. Where a duct branch is to handle more than 25 percent of the air handled by the duct main, use a complete elbow as specified, assembled into a single fitting with the main duct. Size the separate branch and remaining main as shown on the drawings, and partition the division of the combined duct such that each of the branch and main have the same velocity, with cross sectional area proportional to the respective airflow. Join the leading / trailing edge where the branch and main meet airtight via welding or brazing.

3. Where a duct branch is to handle less than 25 percent of the air handled by the duct main, construct the branch connection with a 45 degree side take-off with volume damper in branch line close to takeoff. Round branches off of rectangular main, use 45 deg. entry takeoff with integral transition to round.

a. Supply: increase duct dimension on upstream side of branch by 25 percent, minimum 4 inch.
b. Return: increase duct dimension on downstream side of branch by 25 percent, minimum 4 inch.
c. Multiple flow direction takeoffs: provide twin entries or bell mouths.

4. Where an air-diffusion device is shown as being installed in close proximity to (less than one main duct width) the side, top, or bottom of a duct, provide a commercially manufactured vaned volume extractor fitting to allow adjustment of the air quantity and to provide an even flow of air across the device it services.

F. Duct Entries

1. Wherever air does not enter the duct system from grilles, registers, or louvers, but instead enters directly from an enclosed or exposed plenum space, provide a duct entry transition with a minimum area ratio of inlet to nominal duct size of 2:1 unless otherwise specifically shown and noted.

2. Duct entry may be angled (pyramidal or conical) or with bell-mouth radius.

   a. Provide angled duct entries with a maximum single side angle to axial of 30 deg. Any combination of sides, top, and bottom may be angled (or conical for round duct) to suit space restrictions, but maintain the specified area ratio.

   b. Provide bell-mouthed entries with radius as required maintaining the specified area ratio.

3. Provide entry grille or if not shown, provide at minimum 1/2 inch welded wire mesh (WWM) secured over the large side of the opening of all duct entries.

2.3 ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Spiral lock-seam duct, joints, and fittings:

      1) Lindab Inc.
      2) McGill AirFlow LLC.
      3) SEMCO Incorporated.
      4) Sheet Metal Connectors, Inc.
      5) Spiral Manufacturing Co., Inc.

   b. Longitudinal fusion-welded duct, joints, and fittings as described in appropriate SMACNA manuals and herein – shop fabricated.

   c. 26 ga. G-60 longitudinal snap-lock construction duct, joints, and fittings.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as follows:

1. Spiral lock seam duct:

   a. Machine locked spiral seams with or without formed standing reinforcement ribs.
   b. Leakage through the duct wall and joints certified no greater than design make.
   c. Provide minimum 12 ft. long un-joined lengths, except where interrupted by fittings.

2. Longitudinal seam duct shall have fusion-welded butt seams.

    a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Snap-lock seam duct:

    a. Limit snap-lock construction components and systems to concealed round duct run-outs to individual diffusers, registers, and grilles, in sizes 12 inch and under, with all transverse and longitudinal seams sealed.

    b. Longitudinal seams field assembled by interlocking machine formed sprung tabs, with sealant brushed on before and after assembly.

    c. Provide minimum 10 ft. long un-joined lengths, except where interrupted by fittings or shorter lengths are required to work through existing structure.

D. Transverse Joints - Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as follows:

1. 24 in. diameter and less: slip fit collars or sleeve couplings, reinforced by rolled beads, insertion length 2 inch. Secure with hexagon head drill point screws or other approved mechanical fasteners 6 inch o.c. max and duct sealant.

2. Over 24 inch to 42 inch diameter, general, concealed joints: Provide roll formed, welded angle ring flanges similar to SMACNA T-24 or T-25 configuration. Attach flange to duct with internal stitch or button welds 6 inch o.c. max and duct sealant. Size angle ring gauges per SMACNA recommendations. Secure with #10 “Tec” screws 6 inch o.c. maximum, seal with closed cell gasket.

3. Exposed over 24 inch diameter, all over 42 inch diameter: two piece angle ring flanges, loose fit outer ring in a "Van Stone" configuration. Provide a 5/8 inch flange inner ring as a gasketing surface for sealing, integrally rolled or attached to the pipe with internal button or stitch welds 6 inch o.c. max and duct sealant. Provide outer rolled, welded angle ring sized per SMACNA recommendations. Secure with bolts 8 inch o.c. maximum, seal with closed cell gasket.

E. Elbows:

1. Fabricated to a centerline radius of minimum 1.5 times the cross-section diameter.

    a. Where space constrictions do not allow specified centerline radius or where shown as such on drawings only, provide mitered elbow of fully welded construction with single thickness turning vanes spaced 3 inch o.c. max.

2. For use with snap-lock round duct, where allowed as described above: Gored adjustable elbows, seal adjustable joints after installation.

3. For standard bends (ex. 45 deg. and 90 deg.), diameters through 9 inch: Two-section stamped and welded 22 ga. elbows.

4. Diameters 10 inch through 30 inch, any angle: Gored standing seam construction similar to United McGill “UNI-SEAM”. Less than 36 deg. - two gores, 36 deg. to 72 deg. - three gores, over 72 deg. - five gores.

5. Diameters over 30 inch and odd angles under 10 inch: Gored construction with gores stitch welded 6 inch o.c. max and sealed with duct sealant. Less than 35 deg. - two gores, 36 deg. to 71 deg. -three gores, over 71 deg. - five gores.

F. Tees and Lateral Branches: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as follows:

1. Bull-Headed Tees:

   a. Provide wye fitting with subsequent partial bend elbows for critical run bull-headed tees.
   b. Provide capped main and twin lateral branches as described below for general purpose bull-headed tees.
   c. Provide “bird-mouthed” fitting with turning vanes only where space restrictions require and where specifically shown as such on the drawings.

2. Fabricate lateral tees and all branches with fittings as described herein:

   a. Fabricate to longitudinal welded duct standards. Where possible, provide gored standing seam construction similar to United McGill “UNI-SEAM”, otherwise stitch or button welded or riveted. Seal all joints.

   b. Fitting entrance free of weld build-up or spatter, burrs, or irregularities, not projecting into either the main or branch runs.

   c. Provide manual volume damper at all branch connections.

   d. Typical round branch connections to round main duct, provide 45 deg. reducing lateral takeoff fitting, with subsequent elbow resulting in required branch angle to main.

      1) Where space restrictions do not permit this combination, provide 90 deg. angled rectangular to round takeoff fitting “birdmouthed” to main, or conical takeoff with similar loss coefficient.

2) For critical run (ie. maximum pressure drop) round branch connections to round main ductwork, provide high performance 45 deg. reducing conical lateral takeoff fitting, with subsequent elbow resulting in required branch angle to main.

3) Exposed, duct side mounted register connections may be tapped into side wall of length of duct. Where an air-diffusion device is shown as being installed in close proximity to (less than one main duct width) the side, top, or bottom of a duct, provide a commercially manufactured vaned volume extractor fitting to allow adjustment of the air quantity and to provide an even flow of air across the device it services.

G. Turning Vanes:

1. As described for mitered rectangular elbows of unequal inlet and outlet cross section above.

H. Offsets:

1. All offsets to consist of paired curved elbows, each of the required angle, combined into one fitting.

I. Transitions of shape or cross section and duct entries:

1. As described for rectangular duct above.

2.4 EXTERIOR DUCT

A. Construction as detailed above with the additional requirements listed herein.

B. Seal all exterior duct completely water tight, including all longitudinal and transverse seams, fittings, and branch connections. Seal both during assembly and from the exterior. Use only exterior all weather grade gaskets and sealants. Apply sealants neatly, avoiding exposed sealant on surface. Where sealant must be exposed for function apply in neat fillets.

C. Fabricate all transverse joints using an **INTEGRAL** standing flange reinforcement similar to SMACNA T-24 or T25 as described in the SMACNA HVAC Duct Construction Standards Manual. Use of "slip-on" reinforcing flanges not permitted.

D. Install all exterior duct with minimum 1 inch per 10 ft pitch to avoid standing water puddles on top surface.

2.5 EXPOSED DUCT SPECIAL CONSIDERATIONS

A. Provide aluminum (as required above) or paintable galvanized steel for all exposed supply, return and exhaust duct which will not be externally insulated. Mill phosphatizing in accordance with ASTM A2092 is acceptable material. Use forming lubricants which are compatible with specified painting systems and provide painters with factory recommendations for appropriate and compatible solvents, primers, etc...

B. Welds: exposed welds ground smooth and all weld spatter scraped or ground off.

C. Sealants: use only paintable sealants, applied neatly, avoiding exposed sealant on surface. Where sealant must be exposed for function apply in neat fillets.

D. Avoid all shipping and handling damage to surfaces. Replace pieces that are damaged and not repaired so that repair is not visible.

E. Joints: rotate all spiral seams of round duct so as to form continuous helical spiral. Carefully coordinate installation of exposed duct side mounted register connections as required.

F. Provide tapered "ramp" couplings for joints where allowed by size.

2.6 DUCTWORK ANCILLARY COMPONENTS

A. The ancillary components included in this section are generally required in all air duct systems, need not be specifically called for on the drawings other than by specification or standard symbols and abbreviations, and are required to be detailed in the shop standards submittal.

B. Acoustical and Thermal Duct Liner:

1. Refer to specification section 23 07 00 – HVAC Insulation for duct liner specifications.

2. Where duct liner is used, enlarge ductwork in both directions by double the nominal duct liner thickness to size required to provide for free area dimensions as shown on the drawings.

3. Duct liner used for sound attenuation purposes only to be minimum 1 inch thick or thicker as specified on the drawings.

4. Duct liner used in lieu of external thermal insulation is required to meet the insulation value and associated thickness requirements of section 23 07 00.

5. Duct liner materials and installation, as specified in section 23 07 00, may be submitted under either this section or in section 23 07 00.

C. Duct Connectors

1. Flange Connectors

a. Refer to flange reinforced transverse joint system described under duct construction above. Flanged connections to system components other than adjacent duct sections may be fabricated similar to a transverse joint. If required to connect to equipment or components of different configuration provide flanged connector custom fabricated of reinforcement shapes as specified.

b. Material: Match adjacent duct.

2. Flexible Connectors - Duct to Equipment:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Ductmate Industries, Inc.
2) Duro Dyne Inc.
3) Ventfabrics, Inc.
4) Ward Industries, Inc.; a division of Hart & Cooley, Inc.

b. Provide factory fabricated flexible connectors with heavy gauge metal edge bands double roll crimped each side onto water, flame-retardant, mildew resistant, NFPA approved flexible fabric connector strip.

c. Metal Edge Bands: 2 strips of 2-3/4 inches wide, 0.028-inch- thick G90 galvanized sheet or stainless steel, or 0.032-inch- thick aluminum sheets. Provide same metal and corrosion resistance as connected ducts.

d. Fabric Connector Strip: minimum 3-1/2 inches wide, 20 oz. per square yard fiberglass fabric strip double coated with neoprene (general service), hypalon (outdoors), nitrile (chemical resistant service similar to fume hoods), or silicone (high temperature service similar to kiln or engine exhaust).

e. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Airflow Adjusters:

1. Single Blade Volume and Splitter Dampers:

a. Construction per SMACNA Duct Manual and as noted below.

b. Materials: Match associated duct corrosion resistance requirements.

c. Provide double wall airfoil blade dampers where duct velocity is over 1000 fpm nominal.

d. Maximum blade width 12 inches.

e. Multiple dampers or manufactured multi-blade damper above 600 square inches duct cross section.

f. Bearings and Adjusters:

1) Heavy duty quadrant adjusters with 12 gauge offset handle, captive bolt/wing nut lock in 2” minimum radius slot, split clamp with bolt on 3/8” shaft up to 300 square inch duct, ½” shaft for duct up to 600 square inch cross section.

2) Closed end bearings for duct rated for 2" WG and above.

3) Standoff under quadrant placing quadrant outside of specified duct insulation. Insulate between duct and quadrant.

4) When occurring in acoustically lined ducts, install with insulated "build-outs" per Duct Manual.

2. Multi-blade Manual Volume Dampers:

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Air Balance Inc.; a division of Mestek, Inc.
      2) American Warming and Ventilating; a division of Mestek, Inc.
      3) Flexmaster U.S.A., Inc.
      4) McGill AirFlow LLC.
      5) Nailor Industries Inc.
      6) Ruskin Company.
      7) Trox USA Inc.
      8) Vent Products Company, Inc.

   b. Materials: Match associated duct corrosion resistance requirements.

   c. Standard leakage rating.

   d. Suitable for horizontal or vertical applications.

   e. Frames:

      1) Hat-shaped channels 0.064-inch minimum thickness.
      2) Mitered and welded corners.
      3) Flanges for attaching to walls and flangeless frames for installing in ducts.

   f. Blades:

      1) Opposed-blade design standard unless otherwise noted.
      2) Stiffen damper blades for stability.
      3) Formed single thickness blades allowed up to 1000 feet per minute (fpm) design duct velocity; provide airfoil blades above 1000 fpm.
      4) Galvanized-steel, 0.064 inch thick.

   g. Blade Axles: full length of damper blades, bearings at both ends of operating shaft.

   h. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve bearing as applicable.

   i. Tie Bars and Brackets: Galvanized steel.

   j. Damper Hardware:

      1) Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
      2) Include center hole to suit damper operating-rod size.
      3) Include elevated platform for insulated duct mounting.

k. Jackshaft:

1) Provide as required for adjusting multi section multi-blade dampers simultaneously.

2) Size: 1-inch diameter.

3) Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

4) Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

3. Vaned Volume Extractors

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Variturn RXVA by Carnes, Inc.
2) Model AG-45 / AG-225 by Titus Inc.

b. Factory assembled gang-operated parallelogram mounted single wall turning vanes, designed to be mounted between main and branch ducts at branch duct connections and vary the flow rate extracted to branch air while minimizing turbulence and associated pressure drop.

c. Galvanized steel construction installed with sheet metal screws provides stable operation up to 2500 feet per minute main or branch duct velocity.

d. Single wall radius formed turning vanes with flat trailing and leading edges provide uniform air distribution across the branch duct and overlap in closed position for tight close-off. Vanes spaced no greater than one inch on center up to 18 inch length (measured in direction of main duct airflow) or no greater than two inches on center up to 36 inch length.

e. Fully adjustable from closed (zero protrusion into main duct, zero branch duct flow rate), to fully open (30 degree protrusion into main duct).

f. Where extractor vane length is less than dimension of main duct, provide branch duct with side extensions fully enclosing sides of extractor up to the full open position.

1) Where installed in horizontal duct and the bottom of the main and branch ducts are not in the same plane, provide extension support foot at end of bottom side extension.

g. Provide with adjusting mechanism that securely locks in adjusted position and unlocks allowing for smooth infinite adjustment from closed to open.

1) For extractors up to 18 inches long serving branch ducts provide with internal crank linkage operated by heavy duty manual quadrant and 3/8 inch square shaft.

2) For extractors over 18 inches long serving branch ducts, provide with double wire rod push-pull mechanism secured with welded stud, formed steel captive washer and wing nut.

3) For extractors serving immediately adjacent registers, provide with screw gear operated internal crank linkage operated by key through register face.

E. Duct Access Control

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following. Note not all manufacturers offer all products:

a. American Warming and Ventilating; a division of Mestek, Inc.
b. Carnes.
c. Cesco Products; a division of Mestek, Inc.
d. Ductmate Industries, Inc.
e. Flame Gard, Inc.
f. Flexmaster U.S.A., Inc.
g. Greenheck Fan Corporation.
h. KEES, Inc.
i. Lloyd Industries, Inc.
j. Metal Form Manufacturing, Inc.
k. McGill AirFlow LLC.
l. 3M
m. Nailor Industries Inc.
n. Price Industries.
o. Ventfabrics, Inc.
p. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2. General Purpose Duct-Mounted Service Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

a. Door:

1) Double wall, rectangular.
2) Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
3) Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
4) Fabricate doors airtight and suitable for duct pressure class.

b. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

c. Number of Hinges and Locks:

1) Access Doors Less Than 12 Inches Square: No hinges and two sash locks.

2) Access Doors up to 18 Inches Square: Two hinges and two sash locks.
3) Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
4) Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

3. Instrument Test Access Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

2. Tape Width: 4 inches.

3. Sealant: Modified styrene acrylic.

4. Water resistant.

5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

7. Service: Indoor and outdoor.

8. Service Temperature: Minus 40 to plus 200 deg F.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.

5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.8 HANGERS AND SUPPORTS

A. Provide complete system of Air Duct Hangers and Supports as required by the Air Duct systems included. Refer to Section 23 05 29 – "Hangers and Supports for HVAC Components" for details of Hanger and Support requirements for Air Ducts and associated components.

B. Provide complete system of Air Duct Vibration and Movement Control as required by the Air Duct systems included. Refer to Section 23 05 43 – "Mechanical Vibration and Movement Control" for details of vibration isolation and movement control requirements for Air Ducts and associated components.

C. Flexible Duct Supports and Accessories:

1. Elbow Supports: UL listed for plenum installation molded fiber reinforced plastic elbow support at connections to ceiling mounted devices designed to maintain tension in flex duct and eliminate collapsed elbows. Basis of design: Thermaflex FlexFlow elbows.

2. Flexible Duct Supports: UL listed for plenum installation molded fiber reinforced plastic 1-1/2" wide straps adjustable for 4" to 16" diameter flex duct, supports duct without damaging vapor barrier or collapsing soft insulation or duct. Basis of design: Thermaflex FlexTie straps.

3. Clamps: Re-usable stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size, or single use "zip-tie" strap of plenum rated plastic, sizes 3 through 10 inches diameter maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which duct work is to be installed for compliance with requirements for proper installation.

1. Check all drawings for detailed information and locations and field verify all conditions affecting installation.
2. Notify Architect in writing of any conditions detrimental to proper and timely installation.
3. Obtain Architect's approval before fabrication of any changes in size required by obstructions and job conditions.

4. Proceed with installation only after unsatisfactory conditions have been corrected in an acceptable manner.
5. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 DUCT FABRICATION

A. Fabricate and install as shown on Drawings and in manner coordinated with all construction requirements.

B. Sizes shown on plans are clear inside duct dimensions representing the design hydraulic radius of the duct. Generally, fabricate ductwork of sizes shown on plans. During field verification, confirm that duct of aspect ratio shown fits within general construction constraints coordinated with all other trades. Adjust aspect ratio, joint spacing, reinforcement, etc., as required during coordination process to fit duct of equivalent hydraulic radius where shown. If duct of reduced hydraulic radius is required due to field conditions, submit RFI for direction before proceeding.

C. Flexible Connections: Provided at intake and discharge connections to all motor powered fan air handling equipment and other vibration isolated air handling component connections.

D. Fabricate all ductwork to the SMACNA pressure classification reinforcement standards shown on the drawings and to the following minimum standards.

1. Conform to special duct pressure classification requirements for all duct between air handler blowers up to the next 90 deg. turn:

    a. Fabricate to the SMACNA pressure classification reinforcement standards required by the system supply or return blower dynamic stall pressure; assume the larger of 200% of external operating pressure scheduled or 150% of fan total pressure listed as a minimum. VIF with approved equipment fan curves and adjust pressure classification values accordingly.

2. Past the 90 degree turn mentioned above, complete to the last branch duct volume damper, or other pressure restricting device, fabricate duct to pressure classification as required by the system supply or return operating pressure listed on the drawings, minimum plus or minus two (2) inch water column.

3. Fabricate branch run-out duct between the last pressure restricting device and the air terminal register, grille, or diffuser to minimum plus or minus one (1) inch water column pressure classification.

E. Deliver and store all duct with duct interior clean and all openings sealed with film designed for the purpose of keeping uninstalled duct clean. Unless section of duct is being actively extended during construction, keep all openings and RGD properly sealed and prevent entrance of dust, dirt, construction debris, etc.

F. Extend all access openings, damper rods, and levers to outside of external insulation for convenience of operation and maintenance.

G. Provide all necessary transitions, fittings, aspect ratio changes, etc., as required to install duct work. Where aspect ratio changes are required to fit within structural or other existing construction constraints, provide duct of equal or larger hydraulic radius.

3.3 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install concealed in general construction unless otherwise specified or indicated on Drawings.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Provide all necessary openings, sleeves, hanger inserts, chases, recesses, etc., in general construction work. Coordinate duct openings provided by others in ample time to avoid delays.

E. Provide collars to trim all duct openings in general construction work.

F. Make final ductwork connections to equipment where indicated on the drawings.

G. Install ductwork in all spaces as high as possible and in locations to avoid interference with recessed lights, piping, general construction, etc.

H. Install round and flat-oval ducts in maximum practical lengths.

I. Install ducts with fewest possible joints.

J. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

K. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

L. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

M. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

N. Route ducts to avoid passing through transformer vaults, electrical equipment rooms and enclosures, and stairwells.

O. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

P. Where duct passes through exterior walls and roofs from interior to exterior, provide water and airtight penetration detailing as required, preserving the thermal, moisture, and vapor penetration resistance of the surrounding assembly.

Q. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.4 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds and surrounding heat affected zone to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.5 DUCT SEALING

A. Make system air tight / water tight as required and approved, replacing any poor joints or careless work. Fabricate ductwork to the following SMACNA leakage standards:

1. Seal Class B – 2 inch w.g. and less general supply, return, and exhaust ductwork.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with the requirements of the following:

1. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
2. Section 23 05 29 – Hangers And Supports for HVAC Components.
3. Section 23 05 43 – Mechanical Vibration and Movement Control.

B. Comply with the additional requirements below:

1. SMACNA load tables do not provide for external loads on duct: provide for 200 lb external load on all duct hangers and supports. Increase hanger and support sizes from SMACNA tables accordingly:

a. Minimum band size 20ga. x 1 inch.

b. Duct 48” wide and larger; provide trapeze style support of metal channel framing or angle iron, suspended from threaded rods.

c. Hanger bands to extend down sides and turn under bottom 1 inch minimum for all duct sizes. Minimum (2) #10 sheet metal screws per hanger (one each on side and bottom), (2) screws minimum on sides for duct over 12 inches tall, 12 inches on center max.

2. Hangers Exposed to View:

a. Rectangular duct: threaded rod and angle or channel supports.
b. Round duct: twin half round bands 14 ga min., and threaded rods.

3. Provide hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

4. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

5. Do not allow flexible duct to rest on general construction. Support flexible duct at maximum 3 feet on center.

3.7 CONNECTIONS

A. Make connections at all intake and discharge connections between duct and vibration producing equipment with fans, including CUH, AHU, RTU, FCU, etc.., where duct passes through building expansion joints, and as shown on the drawings, with flexible connectors as specified.

1. Round connections: Adhesive and approved metal draw bands; ends tightly bolted together.

2. Rectangular flanges: Material securely held in grooved seam, tightly clipped or screwed on 6 inch centers.

3. Connections not over 2 inch between duct and equipment, with at least 1 inch excess material.

4. Install neatly so as not to interfere with air flow through connection. Provide round metal center ring or rectangular metal center collar to prevent flex fabric collapse inside of nominal connected duct dimensions.

B. Registers, Diffusers, and Grilles:

1. Install flexible duct connections to registers, diffusers, and grilles with no more than 20 degree unsupported bend in flex. Where horizontal duct connects to vertical axis collar (ex., ceiling mounted diffuser), provide elbow support as specified or hard elbow.

2. Exposed, duct side mounted: Mount outlet outside of air stream with extension collars full size of register or grille frame outside margin, with turned in duct flange and turned out terminal mounting flange. Provide vaned air extractor with internal mechanism / external rotating knob adjuster.

3. Exposed ductwork hard piped connections: per Duct Manual.

3.8 PAINTING

A. Paint interior of ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.9 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 - "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 31 00

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire Dampers.

1.3 PERFORMANCE REQUIREMENTS

A. Provide Ductwork Accessories in compliance with all applicable requirements of Section 23 31 00 – Ductwork and appropriate design and construction manuals issued by Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

B. Fabricate accessories able to withstand the forces imposed by the support and restraint system.

C. Provide dampers of sizes shown on plans (inside duct dimensions).

D. Fire Dampers: Provide dampers listed for the application in locations shown on Drawings or specified in this Section including all new ducts penetrating fire rated general construction and in accordance with NFPA 90A maintaining the fire rated integrity of the general construction.

1.4 ACTION SUBMITTALS

A. Product Data: For all Ductwork Accessories, as required demonstrating compliance with specified requirements.

B. Shop Drawings: For all Ductwork Accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail Ductwork Accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Additionally include the following as required for specific applications:

a. Fire-damper installations: include sleeves and duct-mounted access door locations.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Comply with all applicable codes and as follows.
B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
C. Fire, Smoke, and Combination Fire – Smoke Dampers: Rated, listed, and labeled according to UL 555 and UL 555S by an NRTL.
D. Comply with AMCA 500-D testing for damper rating.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish 3 spare links.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Material Requirements:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.

2. Provide sheet metals per mill specs and free of pits, voids, seam or roller marks, stains, discolorations, inadvertent bends and kinks, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M, G90 coating designation, lock forming quality, unless otherwise specified..

1. Exposed to view, not externally insulated or painted: Galvannealed steel.

2. Exposed to view, to be painted: Galvannealed steel prepared for painting via mill phosphatizing and subsequent heat treatment in accordance with ASTM D6386 and ASTM D7803 as applicable

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304L or 316L Stainless-Steel Sheets; cold rolled, annealed. Minimum surface finish for concealed duct No. 2B exterior of duct, No. 2D interior of duct. Minimum surface finish for duct exposed to view in occupied spaces, No. 4 polish.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.2 CONTROL DAMPERS

A. Refer to Section 23 09 00 – Instrumentation and Control for HVAC for control damper specifications.

2.3 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Metal-Fab Inc.
6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Prefco; Perfect Air Control, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Provide curtain-blade or multi-blade dampers as required by size and application.

C. Type: Dynamic rated and labeled according to UL 555 and/or UL 555S by an NRTL.

1. Rated for ducts up to 4-inch wg static pressure class and 4000-fpm velocity.
2. Mounting Orientation: Vertical or horizontal as required by application.
3. Include blade lock and stainless-steel closure spring sufficient for Mounting Orientation.

D. Fire Rating: 1-1/2 as required; refer to drawings for fire rating of general construction.

E. Frame: Fabricated with roll-formed, 0.034-inch- thick galvanized or stainless steel; with mitered and interlocking corners. Provide frame types and materials as specified and detailed below.

1. Type “C”: 100% free area curtain style with frame and retracted blades outside airstream.

2. For dampers shown or required by general construction conflicts to be installed with damper blades outside of the plane of the fire resistive general construction, provide factory assembly UL listed for this installation including extended reinforced sleeve factory covered with fire rated insulation meeting or exceeding the rating of the surrounding general construction.

F. Mounting Sleeve: Factory- or field-installed, same steel as frame.

1. Minimum Thickness: 0.052 or as required by product listing, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Blades: Roll-formed, interlocking, 0.034 inch thick sheet steel of same type as frame. In place of interlocking blades, use full-length steel blade connectors.

H. Heat-Responsive Device: Replaceable fusible links rated for 165 deg F or other temperature where noted on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where air terminal units are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories with stainless steel fire and fire-smoke dampers in aluminum ducts.

C. Install fire dampers according to UL listing. Provide for adequate perimeter clearance and fire rated flexible infill as required.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
2. Demonstrate proper service access at all dampers.

END OF SECTION 23 33 00

SECTION 23 37 00 – AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior Outlets and Inlets:

a. Registers, grilles, and diffusers

2. Exterior Outlets and inlets:

a. Roof Top hoods

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Registers, Grilles, and Diffusers: Provide all supply, return and exhaust grilles, registers, and diffusers required for all systems.

2. Roof Top Hoods: Provide fresh air intake and exhaust / relief openings, as shown or specified in Contract Documents. Cross- reference dimensions of each penthouse/ hood shown on heating drawings with those on the architectural drawings. Notify architect in writing of any discrepancies prior to submitting on equipment.

1.4 PERFORMANCE REQUIREMENTS

A. Interior Outlets and Inlets: Provide outlets and inlets with aspiration ability, temperature mixing, and velocity traverses and decay with distance, throw, pressure drop, and noise criteria ratings equal to or better than specified products.

1.5 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications, performance data, installation instructions, and similar information required to demonstrate compliance with specified requirements. Annotate all selected options, cross referenced to specification and drawing designations. Include tabulated data for all proposed outlets and inlets, showing size, type, cfm, aspiration ability, water entrainment, temperature mixing, and velocity traverses and decay with distance, throw, pressure drop, noise criteria ratings and any other applicable data demonstrating performance equal to or better than specified products.

C. Shop Drawings: Submit shop drawings showing sizes, construction details, mounting details, capacity, and air flow characteristics for all equipment. Include complete tabulated schedules as indicated below for each of RGD and Roof Top Hoods.

1. Registers, Grilles, and Diffusers (RGD): Include complete tabulated schedule showing locations for each RGD, type, size, capacity as shown on Drawings, and performance data for each RGD furnished, including throw and noise criteria ratings. Indicate selections on data.

2. Roof Top Hoods: Include complete tabulated schedule showing locations for each Roof Top Hood, showing type, size and roof rough opening size, capacity as shown on Drawings, and performance data for each including pressure drop and water entrainment specifications. Include all this data on coordination drawings and special Mechanical Penetrations of General Construction Envelope coordination drawing.

D. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

1.6 SEQUENCING AND SCHEDULING

A. Deliver Exterior Outlets and Inlets (Roof Top Hoods) to project in sufficient time for installation in walls as wall construction progresses.

1. Coordinate unit selection to meet requirements of other equipment and installation details (automatic dampers, back draft dampers, etc.).
2. Verify all opening sizes, locations and mounting arrangements prior to installation.

PART 2 - PRODUCTS

2.1 REGISTERS, GRILLES, AND DIFFUSERS

A. General

1. Provide registers, grilles, and diffusers with border systems that are compatible with adjacent wall and ceiling systems, and that are specifically manufactured to fit into ceiling modules with accurate fit and adequate support. Refer to general construction drawings and specifications for details of adjacent systems.

2. All performance criteria equal to or better than design make as specified and tagged on drawings.

3. Provide factory baked white enamel finish for steel materials and clear or color anodizing for aluminum material as base bid standard finish unless otherwise specified or noted.

4. Provide products by one of the following:

   a. Krueger or equal.
   b. Price or equal.
   c. Anemostat or equal.

B. Registers:

1. TYPE "R-A": Double deflection wall supply register; vertical front and horizontal rear vanes with 3/4" spacing between blades, rubber gasket to prevent streaking, vanes individually adjustable; extruded aluminum construction, clear anodized finish. Similar to Krueger “5880V”, “5880H (horizontal front)”, “R5880” (round duct register with mounting as shown and as required).

2. TYPE "R-E": Spherical ball and socket Punkah style air nozzle constructed of heavy gauge spun aluminum, having at least 70° of angular adjustment. Felt gasket between ball and socket shall provide for air tight seal and smooth adjustment. Provide foam gasketed flange for surface mount or duct collar mount as required. Finish shall be custom color baked enamel. Similar to Krueger “RPN”, “RPNRD”, or “RPNR”.

C. Grilles

1. TYPE "G-A": Eggcrate return grille; 1/2 inch x1/2 inch x1inch deep squares; fabricated aluminum core; flat frame; white baked enamel finish to match ceiling. Neck size and accessories as noted on drawings. Provide frame to fit lay-in ceiling grid or hard ceiling as required. Similar to Krueger “EGC-15”.

2. TYPE "G-C": Single deflection wall return grille; vertical or horizontal vanes, fixed at 0 degrees or 35 degrees (as noted on drawings), with 3/4 inch spacing between blades; aluminum or steel construction as required to match adjoining ductwork. Similar to Krueger “S80" or “S580”.

D. Supply Diffusers:

1. TYPE "D-A": Ceiling air diffuser with stamped steel construction, stamped three ring removable core, 24 inch square face, 4 way pattern, integral round neck of size as noted on drawings. Anti smudge design to prevent streaking. Flush T-bar mount to fit lay-in ceiling grid, coordinate with G.C. Similar to Krueger “1400”.

2. TYPE "D-D": Steel round deep framed diffuser specifically designed for downward vertical projection of heated air from high exposed ductwork. Diffuser shall consist of three expanding distribution cones, regardless of unit size, terminating in closed rolled beads and having no external ledge on which a tennis ball or larger sphere may rest. Size, mount, and capacity as shown. Design make: Anemostat “HU-3”. Other acceptable manufacturers of equivalent product include Kruger, Titus, Price, and Nailor.

2.2 ROOF TOP HOODS

A. Dome Style Roof Top Hoods:

1. Rated for snow and wind load shown on Code Compliance Drawings.

2. Designed for intake or exhaust (relief), as shown on the drawings.

    a. Intake hoods shall have minimum free area at inlet equal to twice the throat cross section.
    b. Exhaust hoods shall have minimum free area at outlet equal to the throat cross section.
    c. Provide closed cell insulation adhered to underside of exhaust /relief hoods to prevent condensation.

3. Heavy gauge (0.060 inch) aluminum construction.

4. All vertical seams continuously welded. Tops stressed and sloped for drainage with standing lock-formed seams; slope by cross breaking only of flat top not acceptable. All mechanical fasteners stainless steel.

5. Provide hinged joint between hood and base for ease of service access.

6. Provide 1/2 inch aluminum bird screen, secured in removable frame to underside of opening.

7. Curb: Install units on minimum 12 inch high insulated curb or higher curb as scheduled; factory fabricated similar to Pate “Model PC-5A”.

8. Size and capacity as shown on the drawings.

    a. Provide scheduled factory finish as detailed below:

        1) Kynar: Provide factory applied and baked resin based paint coating, minimum 70% fluoropolymer (PVDF) similar to Kynar 500 or Hylar 5000 as manufactured by the Valspar Corporation. Coating shall meet all performance requirements of AAMA 2605 and ASCA 96. Color as selected by Architect from manufacturer’s full range of standard or premium colors including minimum 16 “standard” colors and 12 “premium” colors.

9. Provide products by one of the following:

    a. Cook “G” series or equal.
    b. Greenheck “Fabra Hood” or equal.
    c. Twin City Fans and Blowers, “MG” series or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which air outlets and inlets are to be installed and notify a Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 INSTALLATION

A. Install air outlets and inlets in strict accordance with manufacturer's recommended installation instructions for applications shown on Drawings.

B. Registers, Grilles and Diffusers (RGD): Install all RGDs in accordance with manufacturer's installation instructions and SMACNA installation manual at locations indicated on Drawings.

1. Adjust each type of RGD as required to achieve even air distribution throughout occupied space, generally free of objectionable drafts and dead air pockets. Demonstrate adjustments of distribution to Owner and additionally adjust as requested by Owner's representative during or subsequent to initial adjustments. As RGD adjustment and Testing and Air Balancing work affect each other, make preliminary adjustment to all RGDs prior to balancing, and make final RGD adjustment during TAB work in cooperation with TAB agency. Refer to section 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC for more detail.

2. Provide final balancing in accordance with SECTION 23 05 93.

3. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that requires them.

C. Roof-Mounted Hoods

1. Provide roof curbs in sufficient time to coordinate with construction schedule.

2. Verify all opening sizes, locations, and mounting arrangements prior to installation. Provide structural support frame around all roof deck penetrations 12 inches x 12 inches and larger, unless specifically indicated otherwise elsewhere on the Contract Documents..

3. Comply with applicable requirements of SECTION 23 05 29 – Hangers and Supports for HVAC Components.

4. Comply with manufacturer's requirements for securing to curbs. Use appropriate weather proof gasketing and stainless steel fasteners as required meeting loading requirements specified above.

END OF SECTION 23 37 00

SECTION 23 54 00 - FURNACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Gas-fired, noncondensing furnaces and accessories complete with controls.
2. Air filters.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:

1. Furnace.
2. Air filter.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For each furnace to include in emergency, operation, and maintenance manuals for each of the following:

1. Furnace and accessories complete with controls.
2. Air filter.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: 10 years.
b. Integrated Ignition and Blower Control Circuit Board: Five years.
c. Draft-Inducer Motor: Five years.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Disposable Air Filters: Furnish two complete sets.
2. Fan Belts: Furnish one set for each furnace fan.

PART 2 - PRODUCTS

2.1 GAS-FIRED FURNACES, NONCONDENSING

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Bryant Heating & Cooling Systems; Div. of United Technologies Corp.
2. Carrier Corporation; Div. of United Technologies Corp.
3. Goodman Manufacturing Company, L.P.
4. Rheem Manufacturing Company; Air Conditioning Division.
5. Ruud Air Conditioning Division.
6. Thermo Products, Inc.; a division of Burnham Holdings Inc.
7. Trane.
8. York International Corp.; a division of Unitary Products Group.

B. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.

C. Cabinet: Corrosion resistant steel.

1. Cabinet interior around heat exchanger shall be factory-installed insulation.

2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.

D. Fan: Centrifugal, factory balanced, resilient mounted, direct or belt drive.

1. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2. Special Motor Features: Single speed, Premium (TM) efficiency, as defined in Division 23 Section "Common Motor Requirements for HVAC Equipment," and with internal thermal protection and permanent lubrication.

E. Type of Gas: Natural.

F. Heat Exchanger: Type 409 Stainless steel.

G. Burner:

1. Gas Valve: 100 percent safety modulating main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.

2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

H. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

I. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

J. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; and adjustable fan-on and fan-off timing; terminals for connection to accessories.

K. Vent Materials: Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks" for Type B metal vents.

2.2 AIR FILTERS

A. Disposable Filters: 2-inch- thick fiberglass media with ASHRAE 52.2 MERV rating of 8 or higher, in sheet metal frame.

2.3 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.4 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."

2.5 ACCESSORIES

A. 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.

B. NEMA 3R integral disconnect switch.

C. Variable Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

2. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

3. Unit Operating Requirements:

    a. Input ac voltage tolerance of 208 V, plus or minus 5 percent.
    b. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
    c. Minimum Efficiency: 96 percent at 60 Hz, full load.
    d. Minimum Displacement Primary-Side Power Factor: 96 percent.
    e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
    f. Starting Torque: 100 percent of rated torque or as indicated.
    g. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

5. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: 2 to a minimum of 22 seconds.
    d. Deceleration: 2 to a minimum of 22 seconds.
    e. Current Limit: 50 to a minimum of 110 percent of maximum rating.

6. Self-Protection and Reliability Features:

    a. Input transient protection by means of surge suppressors.
    b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
    c. Adjustable motor overload relays capable of NEMA ICS 2, Class 20 performance.
    d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
    e. Instantaneous line-to-line and line-to-ground overcurrent trips.
    f. Loss-of-phase protection.
    g. Reverse-phase protection.
    h. Short-circuit protection.
    i. Motor overtemperature fault.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

8. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

11. Door-mounted LED status lights shall indicate the following conditions:

    a. Power on.
    b. Run.
    c. Overvoltage.
    d. Line fault.
    e. Overcurrent.
    f. External fault.

12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.

13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

    a. Output frequency (Hertz).
    b. Motor speed (rpm).
    c. Motor status (running, stop, fault).
    d. Motor current (amperes).
    e. Motor torque (percent).

f. Fault or alarming status (code).
g. Proportional-integral-derivative (PID) feedback signal (percent).
h. DC-link voltage (volts direct current).
i. Set-point frequency (Hertz).
j. Motor output voltage (volts).

14. Control Signal Interface:

    a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

    b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:

        1) 0 to 10-V dc.
        2) 0-20 or 4-20 mA.
        3) Potentiometer using up/down digital inputs.
        4) Fixed frequencies using digital inputs.
        5) EIA-485.
        6) Keypad display for local hand operation.

    c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hertz).
        2) Output current (load).
        3) DC-link voltage (volts direct current).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hertz).

    d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

        1) Motor running.
        2) Set-point speed reached.
        3) Fault and warning indication (overtemperature or overcurrent).
        4) High- or low-speed limits reached.

15. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

17. Accessories:

    a. Devices shall be factory installed in controller enclosure unless otherwise indicated.

b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

c. Standard Displays:

1) Output frequency (Hertz).
2) Set-point frequency (Hertz).
3) Motor current (amperes).
4) DC-link voltage (volts direct current).
5) Motor torque (percent).
6) Motor speed (rpm).
7) Motor output voltage (volts).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for gas piping systems to verify actual locations of piping connections before equipment installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Beginning construction constitutes Contactor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

C. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

3.3 CONNECTIONS

A. Gas piping installation requirements are specified in Division 22 Section " Natural-Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings and adjust belt tension.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.
B. Install new filters in each furnace within 14 days after Substantial Completion.

END OF SECTION 23 54 00

SECTION 23 62 13 – UNITARY AIR CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Split System Heat Pump.

B. Products Furnished but not Installed Under this Section

1. Associated refrigerant piping and condensate drain piping.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Cooling performance rated in accordance with AHRI Testing.

2. Unit efficiencies meet scheduled performance and exceed Energy Code Requirements.

3. Units listed and labeled by UL and ETL.

4. Provide all refrigeration equipment and related installation in compliance with the latest editions of the Mechanical Code of NYS chapter 11, the safety code for mechanical refrigeration ASHRAE Standard 15, and ANSI Refrigeration Safety Code B 9.1.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Provide manufacturer's specification data for each unit, showing operating weight, all sizes, dimensions, capacity, operating and performance characteristics, motor horsepower, and other pertinent data including color chart.

C. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT HEAT/COOL AIR CONDITIONING UNIT

A. Unit Description: Unit bearing AHRI Certification Symbol and listed by ETL Testing Laboratories, Inc. consisting of outdoor unit which contains refrigerant compressor and can provide cooling only or heating and cooling of spaces, indoor unit connected by insulated copper refrigerant tubing with flare type fittings. System equipped with factory-installed solid core filter drier, large capacity suction accumulator, low ambient controls, and other accessories as specified and as scheduled.

1. Refrigerant Run Capability: 130 feet of lift with maximum tubing length of 130 feet of interconnecting piping for up to 1.5 ton capacity unit, and 50 feet of lift with maximum tubing length of 164 feet for unit with greater than 1.5 ton capacity up to 3.5 ton capacity.

2. Refer to drawings for capacities and performance ratings.

B. Refrigerant: Sufficient R-410A or 407C refrigerant provided in outdoor unit to charge complete system.

C. Outdoor Condensing Unit: Outdoor with inverter driven variable speed compressors which provides efficient cooling and heating performance.

1. General data:

a. Factory assembled and pre-wired with all necessary electronic and refrigerant controls.

b. Refrigeration circuit consisting of a digital scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, service isolation valves, oil separators, service ports, liquid receivers and accumulators.

c. Both liquid and suction lines must be individually insulated between the outdoor and indoor units on heat pump units. Liquid line insulation is not required on cooling only units.

d. The outdoor unit can be wired and piped with outdoor unit access from left, right, rear or bottom.

e. The sound pressure at rated conditions: maximum of 58 decibels dB(A) at 3 feet from the front of the unit. Provide with night operation mode capable of operating at further reduced noise.

f. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.

g. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

h. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers, and sub-cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.

i. The outdoor unit shall be capable of full heat pump heating operation at 0°F dry bulb ambient temperature without additional low ambient controls. Provide for 100% heat pump heating capacity down to minus 4 deg F, with partial capacity heat pump operation down to no greater than minus 13 deg F.

2. Unit Cabinet:

a. The outdoor unit shall be completely weather proof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

3. Fan:

a. The outdoor unit shall consist of one or two propeller type, direct-drive fan motors that have multiple speed operation via a DC inverter.
b. The outdoor unit fan motor shall have multiple speed operation of the DC inverter type, controlled to modulate as required to maintain head pressure.
c. The fan motor shall have internal thermal overload protection and permanently lubricated bearings and be mounted on rubber in shear isolators.
d. Provide a fan guard to prevent contact with moving parts, constructed of welded wire and plated or painted for corrosion resistance.

4. Outdoor Coil:

a. Manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be of a waffle louver fin and high heat exchanger, rifled bore tube design to ensure highly efficient performance.
c. The coils shall be complete with corrosion treatment of an acrylic resin type. The thickness of the coating must be between 2.0 to 3.0 microns.

5. Compressor:

a. The scroll compressor shall be variable speed (PWM inverter) controlled, changing speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.

b. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type with a maximum speed of 6,480 rpm.

c. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

d. The capacity control range shall be modulating from 14% to 100%.

e. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

f. Oil separators shall be standard with the equipment together with an oil balancing circuit.

g. The compressor shall be mounted to avoid the transmission of vibration.

6. Electrical:

a. The power supply to the outdoor unit shall be in voltage and phasing as shown on the drawings, with a tolerance of +/- 10% from nominal indicated.

b. The control voltage between the indoor and outdoor unit shall be low voltage control wiring compatible with the energy management and control system as specified in Section 23 09 00. The control wiring shall be a multiplex communication system, making it possible to connect multiple indoor units to one outdoor unit with one cable, thus simplifying the wiring operation.

D. Indoor Unit – Ceiling Cassette Unit

1. General: The indoor unit model shall be a ceiling cassette fan coil unit, operable with scheduled refrigerant, for installation into the ceiling cavity with an air panel grille. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized control shall be used to maintain room temperature within 1°F. The indoor units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

2. Indoor Unit:

a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

c. Both refrigerant lines shall be insulated from the outdoor unit.

d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.

e. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.

f. Indoor units shall be capable of accepting outside air delivered though sidewall knock-outs sized for acceptance of scheduled outside air flow rates.

g. The indoor units shall be equipped with an insulated corrosion proof condensate pan under the coil capturing and controlling all condensate.

h. Provide a condensate pump with a 21 inch lift located below the coil in the condensate pan, complete with a built in safety high level alarm and interlock.

i. The indoor units shall be equipped with a return air thermistor.

j. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

k. The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:

a. The cabinet shall be space saving and shall be located into the ceiling.
b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
d. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Fan:

a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
c. The air flow rate shall be available in high and low settings.
d. The fan motor shall be thermally protected.

5. Filter:

a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

6. Coil:

a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
c. The coil shall be a 2 row evaporator coil completely factory tested.
d. A thermistor will be located on the liquid and gas line.

7. Electrical:

    a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
    b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
    c. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

8. Control:

    a. The unit shall have controls provided to perform input functions necessary to operate the system.
    b. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.

E. Controls:

1. Provide intelligent touch controller to control entire system. Provide gateway to seamlessly interface with EMCS.
2. Provide Simplified wired remote controller for each space. All room controllers to wire to intelligent touch controller which can be monitored at the OWS.

F. Manufacturers:

1. Basis of design is as scheduled on the drawings.

2. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Carrier / Toshiba.
    b. Daikin.
    c. Sanyo.
    d. Trane / Mitsubishi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which unitary air conditioning equipment is to be installed and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When conditions are confirmed to be acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable.

3.2 INSTALLATION

A. Install in strict accordance with manufacturer's recommendations and as follows.

1. Provide combination equipment / piping curb in proper position on roof, secured and leveled as recommended by manufacturer. Provide sufficient portals in pipe penetration portion of curb for refrigerant, electrical power, and control wiring.

B. Provide all required supports, attachment devices, vibration isolators, gasketing, sealants, and accessories needed to insure stable, quiet, leak free operation.

C. Provide all refrigerant piping in strict accordance with section 23 23 00 – Refrigerant Piping.

D. Run insulated condensate drain line to approved point of indirect waste disposal through properly sized P-trap. Pitch drain line continuously in direction of flow. If gravity drain is not possible, provide condensate removal pump as specified, piped to nearest approved point of indirect waste disposal.

3.3 FACTORY START UP AND FIELD QUALITY CONTROL

A. Provide authorized factory representative to start-up unit, check following items, and furnish report:

1. Measure and check voltage of components.
2. Check removal of shipping bracing.
3. Proper connection of drains.
4. Check control circuitry, operation, and performance during all modes of operation.
5. Fan check (RPM, motor amps, rotation, belt tension, etc.).
6. All wiring circuits.
7. All accessory equipment operation, such as filters, controls, condensate drain, etc.

END OF SECTION 23 62 13

SECTION 23 63 00 – REFRIGERANT CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Remote air-cooled condensing units.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Remote Air-Cooled Condensing Unit: Arranged for vertical airflow with fan design condensers performing as specified. Factory assembled, leak tested, evaluated, and charged with replacement holding charge. Provides maximum allowable fan outlet velocities and coil face velocities indicated in Contract Documents.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Provide manufacturer's specifications data for each unit, showing operating weight, all sizes, dimensions, capacity, operating and performance characteristics, motor horsepower, and other pertinent data. Include manufacturer's installation instructions.

1. Remote Air-cooled Condensing Unit: Indicate fan outlet velocities and coil face velocities.

C. Shop Drawings: Show on shop drawings equipment, piping connections, valves, strainers, thermostatic valves, and piping schematic required for complete system.

1. Include refrigerant piping diagram.

D. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

1.5 WARRANTY

A. Manufacturer's Warranty: Standard 1-year warranty covering entire unit with 5-year parts-only warranty covering compressor and entire refrigerant circuit.

PART 2 - PRODUCTS

2.2 REMOTE AIR-COOLED CONDENSING UNIT (MORE THAN 10 TONS CAPACITY)

A. Unit Description: Self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral sub-cooling circuit(s), filter drier(s), and controls. Refrigerant shall be R407C, R410A, or as otherwise specifically scheduled. Refer to Drawings for capacities and performance ratings.

B. Casing: 18 gauge zinc-coated galvanized steel frame and panels with weather resistant, baked enamel finish.

C. Condenser Coil: Constructed of seamless copper tubes mechanically expanded into rippled aluminum fins for permanent metal-to-metal contact and provided with full depth fin collars completely covering copper tube.

1. Copper tubes attached to headers with heavy wall fittings for maximum resistance to piping strain and vibration due to discharge gas pulsation.

2. Coils have working pressure of 450-psig with one 450-psig relief device circuit field-installed.

3. Coils factory leak-tested, dehydrated, evacuated, and sealed with holding charge of nitrogen.

D. Refrigerant Circuits: Provide multiple independent circuits as scheduled.

E. Fan and Fan Motors:

1. Fans: Direct drive propeller type with maximum rotating speed of 1200 rpm and maximum fan diameter not exceeding 28 inches.

2. Fan Guards: Heavy-gauge, closed meshed, steel wire, zinc plated and iridite-dipped; contoured for maximum rigidity.

3. Fan Motors: Weatherproof motors suitable for outdoor use, with permanently lubricated totally enclosed motor, with ball bearings and built-in thermal overload protection.

F. Controls: Low ambient operating package allowing starting and operation at temperatures down to 0deg. F., located in weatherproof enclosure, and including:

1. High pressure cut out.
2. Low pressure cut out.
3. Compressor overload relays.

4. Variable speed fan control module with head pressure feedback.
5. Internal compressor winding high temperature thermostat
6. Liquid line temperature sensors.
7. High-pressure fusible plug.
8. Oil failure cut out.
9. Five-minute anti-recycle timer.
10. Liquid line solenoid valve installed at evaporator coil.

G. Compressors:

1. Scroll-Type Compressors: Industrial grade, energy-efficient direct-drive 3600 RPM maximum speed scroll type, with suction gas cooled hermetic design motor with capacity modulation to below 30% capacity via variable speed driven or Copelend digital scroll technology, centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. Solid-state temperature sensor embedded in motor windings to protect against excessive winding temperatures.

3. Provide compressor with automatic capacity reduction equipment consisting of suction valve un-loaders using electric solenoid actuated lifting mechanism operated by oil pressure and providing for unloaded compressor start.

4. Motor designed for “across the line” starting and suitable for voltage utilization range of +/- 10 percent from nameplate voltage.

H. Accessories - All units provided with:

1. Filter dryer
2. Liquid line solenoid valve
3. Sight glass
4. Refrigerant service valves
5. Spring isolators per manufactures recommendations

I. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Design Manufacturer: Trane.

2. Specified equivalents:

a. Daiken or equal
b. Lennox or equal.
c. Reznor or equal.
d. Carrier or equal.
e. York or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which refrigerant condensing units are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. Install Remote Air-Cooled Condensing Units in strict accordance with manufacturer's recommendations as required providing a complete and properly operable system, and as follows.

B. Provide proper roof mounted supports:

1. Units larger than 3 tons capacity: Install roof mounted condensing units on equipment support rails as detailed. Provide pipe penetration curb for refrigerant piping and electrical penetrations of roofing. Install vibration isolation on all roof mounted units and piping

C. Provide all refrigerant piping as specified in section 23 23 00 – Refrigerant Piping, and as additionally recommended by condensing unit manufacturer.

D. Provide all required supports, attachment devices, vibration isolators, gasketing, sealants, and accessories needed to insure stable, quiet, leak free operation.

3.3 FACTORY START UP AND FIELD QUALITY CONTROL

A. Provide authorized factory representative to start-up unit, check following items, and furnish report:

1. Proper connection of all power and ground wiring.

2. Measure and check voltage of components.

3. All wiring circuits.

4. Check removal of shipping bracing.

5. Check control circuitry, operation, and performance during all modes of operation.

6. Fan check (RPM, motor amps, rotation, belt tension, etc.).

7. Check all refrigerant piping, refrigerant charge, operating temperatures and pressures, superheat, sub-cooling, condition and location of specialties including isolation valves, charging ports, dryers, filters, etc.

8. All accessory equipment operation, such as filters, controls, etc.

END OF SECTION 23 63 00

SECTION 23 73 00 - MODULAR OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Variable-air-volume, single-zone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.

2. Cabinet material, metal thickness, finishes, insulation, and accessories.

3. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.

5. Energy recovery devices, including performance ratings with system operating conditions indicated.

6. Dampers, including housings, linkages, and operators.

7. Filters with performance characteristics.

8. Variable Frequency Controllers.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Support location, type, and weight.
2. Field measurements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. 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.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
C. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.
D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
F. Comply with NFPA 70.

1.9 COORDINATION

A. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Three set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Air Enterprises, Inc
2. Carrier Corporation
3. McQuay International
4. Trane
5. YORK International Corporation

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Double walled unit casing constructed of G90 galvanized steel or 3000 series aluminum. Minimum 18 ga. outer wall, minimum 22 ga. inner wall, minimum 18 ga. inner floor, assembled in a stressed skin plenum casing configuration with frame, panels, and assembly of sufficient strength and rigidity to meet the internal pressure performance requirements of these documents.

    a. Aluminum shall be thicker as described in SMACNA HVAC design manuals as required for comparable strength and stiffness.

2. Wall thickness shall be as required to achieve a maximum U value of 0.077 btu-in/ hr-ft^2-deg. F (R=13); 2” minimum on top, sides, and bottom.

3. Unit Roof: Sloped minimum 0.25 inch per foot either from one side of unit or from center to sides of unit with roof assembly overhanging all walls of units by 1.5 inches minimum.

4. Sealing: All seams shall be taped and caulked with RTV silicone to prevent air and water leakage.

5. Casing Coating: Casing shall be phosphoric acid cleaned, coated with a baked zinc rich epoxy enamel primer (galvanized panels), and finish coated with a high gloss alkyd enamel. Finish coats shall exhibit no blistering and less than .040” undercutting after 100 hours exposure, in a scribed condition, to 5% salt spray test at 95 deg. F and 95% relative humidity per ASTM B-117.

6. Units With Outside Air Requirements: Hoods sized for 100 percent economizer cycle. Alternately, provide manufacturer’s standard outside air inlet hood, with louvers tested by Independent AMCA approved laboratory for water carryover and air pressure drop in accordance with AMCA Standard 500 as required to eliminate water entry under design wind driven rain conditions, and submit applicable testing reports.

B. Casing Insulation and Adhesive:

1. Materials: Insulation shall be polyurethane or phenolic foam, or minimum 3.0 lb/cu ft density fiberglass with a maximum k value of 0.21 btu-in/ hr-sq ft-EF.
2. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.

2. Inspection and Access Panels:

   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels 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.

3. 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: At least 16 inches wide (or maximum width allowable by section) by full height of unit casing up to a maximum height of 60 inches.

4. Locations and Applications:

   a. Fan Section: Doors and access panels.
   b. Access Section: Doors.
   c. Coil Section: Inspection and access panel.
   d. Damper Section: Doors.
   e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
   f. Mixing Section: Doors.

D. Condensate Drain Pans:

1. Fabricated with one percent slope 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.

   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.

2. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.

3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

   a. Minimum Connection Size: NPS 1.

4. Pan-Top Surface Coating: Asphaltic waterproofing compound.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Size / design for mid-life filter resistance equal to the average of the as specified clean filter resistance at the design flowrate and the filter manufacturer's recommended maximum (in need of changing) filter resistance at the design flow rate.

2. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

1. The fan shall be a single-width, single-inlet, multiblade-type direct-drive plenum fan. Fans shall be certified as complying with AHRI Standard 430 for airflow performance. Fans shall be tested and rated in-accordance with AHRI Standard 260 for sound performance.

2. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. Fans selected with inverter balancing shall have a maintenance free grounding assembly installed on the fan motor to discharge both static and induced shaft currents to ground.

C. Fan Shaft Bearings:

1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 250,000 hours according to ABMA 9.

D. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches.

E. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Electrical Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

F. Variable Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

2. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

3. Unit Operating Requirements:

a. Input ac voltage tolerance of 208 V, plus or minus 5 percent.
b. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
c. Minimum Efficiency: 96 percent at 60 Hz, full load.
d. Minimum Displacement Primary-Side Power Factor: 96 percent.
e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
f. Starting Torque: 100 percent of rated torque or as indicated.
g. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

5. Internal Adjustability Capabilities:

a. Minimum Speed: 5 to 25 percent of maximum rpm.
b. Maximum Speed: 80 to 100 percent of maximum rpm.
c. Acceleration: 2 to a minimum of 22 seconds.
d. Deceleration: 2 to a minimum of 22 seconds.
e. Current Limit: 50 to a minimum of 110 percent of maximum rating.

6. Self-Protection and Reliability Features:

a. Input transient protection by means of surge suppressors.
b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
c. Adjustable motor overload relays capable of NEMA ICS 2, Class 20 performance.

d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
e. Instantaneous line-to-line and line-to-ground overcurrent trips.
f. Loss-of-phase protection.
g. Reverse-phase protection.
h. Short-circuit protection.
i. Motor overtemperature fault.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

8. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

11. Door-mounted LED status lights shall indicate the following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.

12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.

13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

a. Output frequency (Hertz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percent).
f. Fault or alarming status (code).
g. Proportional-integral-derivative (PID) feedback signal (percent).
h. DC-link voltage (volts direct current).
i. Set-point frequency (Hertz).
j. Motor output voltage (volts).

14. Control Signal Interface:

    a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

    b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:

        1) 0 to 10-V dc.
        2) 0-20 or 4-20 mA.
        3) Potentiometer using up/down digital inputs.
        4) Fixed frequencies using digital inputs.
        5) EIA-485.
        6) Keypad display for local hand operation.

    c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hertz).
        2) Output current (load).
        3) DC-link voltage (volts direct current).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hertz).

    d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

        1) Motor running.
        2) Set-point speed reached.
        3) Fault and warning indication (overtemperature or overcurrent).
        4) High- or low-speed limits reached.

15. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

17. Accessories:

    a. Devices shall be factory installed in controller enclosure unless otherwise indicated.

    b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

c. Standard Displays:

1) Output frequency (Hertz).
2) Set-point frequency (Hertz).
3) Motor current (amperes).
4) DC-link voltage (volts direct current).
5) Motor torque (percent).
6) Motor speed (rpm).
7) Motor output voltage (volts).

2.4 ELECTRICAL/CONTROLS SECTION

A. Provide for single connection of power to unit for fan variable frequency controllers and energy recovery wheel.

1. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
2. Mount unit-mounted NERMA 3R disconnect switches on exterior of unit.

B. Convenience Outlet: GFCI, 120V/15amp, 2 plug, convenience outlet, unpowered.

2.5 COIL SECTION

A. General Requirements for Coil Section:

1. Provide unit casing of sufficient size for a service compartment with ample room for all coil connections, specialties, and service access within the (rectangular) unit casing and behind an access door. Seal field piping penetrations of unit casing with flexible elastomeric deck piping penetrations similar to Pate pipe seals.

2. Comply with AHRI 410.

3. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

4. Coils shall not act as structural component of unit.

B. Water Coils:

1. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
3. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.
4. Fins: Aluminum, minimum 0.006 inch thick.
5. Headers: Cast iron with drain and air vent tappings.

C. Steam Coils:

1. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 100 psig, 400 deg F.

3. Tubes: ASTM B 743 seamless copper, minimum 0.025 inch thick.
4. Fins: Aluminum, minimum 0.006 inch thick.
5. Headers: Seamless copper tube with brazed joints, prime coated.
6. Provide with pressure-equalizing device connected to return line beyond trap as required.

D. Refrigerant Coils:

1. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
2. Minimum Working-Pressure/Temperature Ratings: 300 psig.
3. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.
4. Fins: Aluminum, minimum 0.006 inch thick.
5. Suction and Distributor Piping: ASTM B88, Type L copper tube with brazed joints.

E. Ultraviolet lights:

1. Where scheduled, provide UV-C light fixtures and lamps between cooling coil and supply fan.

2. The UV-C fixtures shall be factory-assembled and tested in the air handler. Lamp life shall be 9,000 hours minimum with no more than a 15% loss of output after one year of continuous use. The UV-C fixtures and lamps shall be accessible via downstream door for maintenance of the bulbs. Fixtures shall meet the UL drip-proof design criteria. Fixtures shall be constructed of UV resistant polymer to resist corrosion. Fixtures shall have been tested and recognized by UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards 153, 1598 & 1995.

3. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be UVC resistant or shielded from the UV-C light using a certified UV-C tolerant material such as metal.

4. Access doors shall be provided at the location of each UV-C light as indicated on the plans and schedule. A window or viewport shall be provided to allow viewing of the UV-C light array to confirm operation. The AHU windows shall be treated to assure the UV-C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.

5. All sections of the handler with access doors where the UV-C lights may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door is opened. Each UV section shall also be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the UV-C lights. The switch shall be equipped with a lock-out/tagout to prevent unwanted operation of the UV-C lights.

2.6 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.

2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.
2. Thickness: 2 inches and 4 inches.
3. MERV (ASHRAE 52.2): 8 and 13.
4. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
5. Media-Grid Frame: Galvanized steel.
6. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.7 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

C. Recirculation and Economizer Bypass Dampers: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod in reinforced cabinet.

D. Outdoor-Air and Exhaust Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 3 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

2.8 AIR-TO-AIR ENERGY RECOVERY

A. Heat Wheels:

1. Rotor: Polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating. Construct media for passing maximum 800-micrometer solids.

2. Drive: Fractional horsepower motor and gear reducer and self-adjusting multilink belt around outside of rotor.

2.9 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Hydronic and Steam Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

D. Refrigerant Coils: Factory tested to 450 psig according to AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Roof Installation Equipment Mounting: Install curb in proper position on roof, and secure curb base to roof framing with anchor bolts, secured and leveled as recommended by manufacturer and in accordance with 23 05 43 "Mechanical Vibration and Movement Control". Provide warranted weather tight installation.

B. Install units with clearances for service and maintenance.

C. On units where the heating coil is supplied as an integral part of a rooftop unit, provide freeze protection circuitry as more fully described in SECTION 23 09 00 - Instrumentation and Control for HVAC.

D. Arrange installation of units to provide access space around air-handling units for service and maintenance.

E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

F. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, 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.

E. Hot-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam Piping: Comply with applicable requirements in Division 23 Section "Steam and Condensate Heating Piping." Install shutoff valve and union or flange at each coil supply and return connection.

G. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

H. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Ductwork."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan 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.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations.

5. Verify that bearings, and other moving parts are lubricated with factory-recommended lubricants.

6. Verify that all dampers open and close.

7. Comb coil fins for parallel orientation.

8. Install new, clean filters.

9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, and fan wheel. Adjust fan to indicated rpm. Replace fan as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units 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 23 73 00

SECTION 23 74 00 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Hot-gas reheat.
3. Steam heating coils.
4. Economizer outdoor- and return-air damper section.
5. Roof curbs.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VVT: Variable-air volume and temperature.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.
2. Roof openings
3. Roof curbs and flashing.

B. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

B. Warranty: Executed special warranty specified in this Section.

1.8 QUALITY ASSURANCE

A. AHRI Compliance:

1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

C. UL Compliance: Comply with UL 1995.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Three sets of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AAON, Inc.
2. Addison Products Company.
3. Carrier Corporation.
4. Engineered Air.
5. Lennox Industries Inc.
6. McQuay International.
7. Valent Air Corporation, LLC.
8. YORK International Corporation.

2.2 CASING

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. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.052 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.024 inch thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 2 inch.
3. Thermal Resistance: R-13.
4. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
5. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.

2.3 FANS

A. Size / design for mid-life filter resistance equal to the average of the as specified clean filter resistance at the design flowrate and the filter manufacturer's recommended maximum (in need of changing) filter resistance at the design flow rate.

B. Direct-Driven Supply-Air Fans: Double width, airfoil plenum; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Fan Motor: Comply with requirements in Division 23 Section "Common Electrical Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Coil Split: Interlaced.
3. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

C. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

D. Steam Coil

1. Double copper tube steam distributing freeze resistant type sloped for drainage, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig. Provide a pressure-equalizing device (vacuum breaker) factory installed to prevent the retention of condensate in the coil, complete with tubing for connecting the equalizing device to the condensate return line beyond the trap.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two.

B. Compressor: Inverter Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Manual-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. 2” Aluminum filters for OA intake: Minimum 80 percent arrestance, and MERV 8.
2. 2” Pleated at coil inlet: Minimum 90 percent arrestance, and MERV 8.
3. 2” Pleated at coil inlet (after MERV8): Minimum MERV 13.

2.7 DAMPERS

A. Barometric Relief-Air Damper: Linked damper blades, for 0 to 25 percent relief air, with bird screen and hood.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.

2.8 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."

2.10 ACCESSORIES

A. 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.

B. Filter differential pressure switch with sensor tubing on either side of mixed air stream filters. Set for final filter pressure loss.

2.11 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Mechanical Vibration and Movement Control."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or II.
b. Thickness: 2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.

b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 14 inches minimum. Refer to schedules.

D. Plenums: Provide plenum curbs (refer to schedules) with field cut openings to allow horizontal duct connections as indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

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.
E. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Ductwork."
4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
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.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.

2. Inspect for visible damage to compressor, coils, and fans.

3. Inspect internal insulation.

4. Verify that labels are clearly visible.

5. Verify that clearances have been provided for servicing.

6. Verify that controls are connected and operable.

7. Verify that filters are installed.

8. Clean condenser coil and inspect for construction debris.

9. Remove packing from vibration isolators.

10. Inspect operation of barometric relief dampers.

11. Verify lubrication on fan and motor bearings.

12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

13. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

14. Inspect and record performance of interlocks and protective devices; verify sequences.

15. Operate unit for an initial period as recommended or required by manufacturer.

16. Calibrate thermostats.

17. Adjust and inspect high-temperature limits.

18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

19. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 74 00

SECTION 23 74 13 – MULTIZONE ROOFTOP AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide labor, materials, equipment and services required to perform the complete installation, startup, testing, and related work for the air handling systems indicated in the contract documents.

B. Section Includes:

1. Heat wheels.
2. Three deck multizone rooftop air handling units designed to fit existing multizone duct and curbing.

C. Complete units shall have:

1. Supply and return blowers,
2. Hot water heating coils, piping, and specialties,
3. Power wiring factory pre-wired to a central control panel with disconnect,
4. Corrosion resistant construction throughout, required by design and function to resist an exposed marine rooftop environment in a durable fashion, and
5. Dampers, filters, drain pans, and other accessories as specified below and as required to provide a completely functional unit as intended.
6. Third deck coil section to accommodate future cooling coil.

1.3 PERFORMANCE REQUIREMENTS

A. Condensate Control Performance: No condensate shall form anywhere on or around the complete unit that is not controlled by condensate pans and directed to drain though condensate piping provided as a part of this Contract.

B. Casing Tightness Performance: All seams shall be gasketted, taped, and caulked with RTV silicone during assembly to limit unit air leakage to less than 1% of system design flowrate at system design pressures.

C. Energy Recovery Performance: Provide air-to-air energy recovery heat exchanger(s) that perform as scheduled on the drawings as a minimum.

1. Effectiveness shall be defined as the amount of energy recovered from a unit of the exhaust air (either sensible, in the case of fixed plate exchangers, or enthalpy, in the case of rotary wheels) divided by the difference between that units dry air mass return air stream energy and that units dry air mass outside air energy, times 100%.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Existing Field Condition Verification: Prior to submitting final submittal, manufacturer shall field measure and adjust unit dimensions and connection to match existing connection points for each unit, including (but not limited to): roof curb (support), duct (combined return and zone supply), pipe (heating) and wiring (power).

1.5 ACTION SUBMITTALS

A. Product Data: For each unit. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For each unit. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural members to which equipment or suspension systems will be attached.

1.7 CLOSEOUT SUBMITTALS

A. Field quality-control reports.
B. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. 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.

B. AHRI Compliance:

1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."

2. Capacity ratings for air coils shall comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:

1. ETL listed and wired according to the NEC with UL listed power components.

F. Comply with NFPA 90A requirements for flame spread and smoke generation, including the unit insulation.

G. Air flow data in accordance with AMCA 210 testing method.

1.9 COORDINATION

A. Coordinate sizes and locations with actual equipment provided.
B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with existing conditions and actual equipment provided.

1.10 WARRANTY

A. Materials and Workmanship of complete assembly shall be factory warranted for a minimum period of one year after owner’s final acceptance of complete installation.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each filter bank.
2. Wheel Belts: One set of belts for each heat wheel.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site

1. Inspect the factory packaging before opening and note any damage on the packing slip. Unpack and inspect the unit before acceptance. Dents or scratches of the casing of the unit, or substantial damage to the packing materials that may indicate internal damage to the unit, shall be cause for rejection of the unit.

B. Storage and Protection

1. After acceptance on site, until such time as the unit is being actively installed, package the unit in protective materials and stored in a protected location so as to protect the function and appearance of the unit in the as accepted condition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Innovent or equal.
2. Aaon or equal.
3. Mammoth or equal.
4. Seasons4 or equal.

2.2 HOUSING CONSTRUCTION

A. Frame: Welded structural steel channel designed to protect the integrity of the case during lifting. Provide integral welded lifting lugs. Base shall be protected with corrosion resistant coating.

B. Casing:

1. Provide unit casing designed for exterior rooftop installation:

a. Sloped roof with cross-broken panels and capped standing seam fabricated joints guaranteed to prevent leakage, and full perimeter gutter.
b. Gasketed side panels.
c. Secondary leak protection sub-floor with penetration collars and positive drainage.

2. Double walled unit casing constructed of G90 galvanized steel or 3000 series aluminum. Minimum 18 ga. outer wall, minimum 22 ga. inner wall, minimum 18 ga. inner floor, assembled in a stressed skin plenum casing configuration. Aluminum shall be thicker as described in SMACNA HVAC design manuals as required for comparable strength and stiffness. Wall thickness shall be as required to achieve a maximum U value of 0.077 btu-in/ hr-ft^2-deg. F (R=13); 2" minimum on top, sides, and bottom. No insulation shall be exposed to either air stream. Insulation shall be polyurethane or phenolic foam, or minimum 3.0 lb/cu ft density fiberglass with a maximum k value of 0.21 btu-in/ hr-sq ft-EF. Interior partitions between different airstreams shall also be 1 inch minimum insulated double wall. All seams shall be taped and caulked with RTV silicone to prevent air and water leakage. Alternatively, the casing may be made of comparable strength (ie). All fasteners shall be stainless steel.

3. Steel casing shall be phosphoric acid cleaned, coated with a baked zinc rich epoxy enamel primer (galvanized panels), and finish coated with a high gloss alkyd enamel. Finish coats shall exhibit no blistering and less than .040" undercutting after 100 hours exposure, in a scribed condition, to 5% salt spray test at 95 deg. F and 95% relative humidity per ASTM B-117. Exterior color to be selected by Architect from the manufacturer's standard colors.

4. Miscellaneous parts same aluminum as casing or 300 series stainless steel unless otherwise scheduled or approved.

C. Maintenance Access:

1. Provide access doors for all internal serviceable components, including blowers, filters, heat exchanger, dampers, actuators, drain pans, and coils. Doors shall be 2 inch double wall, at full height, gasketed leak tight, have full length continuous hinges, minimum two compression latches operable from the inside as well as outside, with stainless steel hold back catches to prevent accidental closure. No plastic parts shall be used. All access doors (except for filters) shall have 22 inch minimum open width.

2. The entire casing shall be removable if required for major service access.

3. Provide personnel guards around blowers as indicated below.

4. Provide removable walk-on grating over return duct openings in unit floor of units over five feet tall interior height.

D. Outside Air Intakes:

1. Provide outside air intakes with AMCA rated drainable blade louvers, sized for no faster face velocity than one half their rated incipient water intake velocity. Include data in submittal.

E. Drain Pans:

1. Provide individually sealed drain pans beneath the coil and future cooling coil section. Minimum 1 inch internally threaded pipe drain outlets for field piping. Contractor responsible for properly sized trap and field connection of drains to nearest approved indirect waste receptor.

2. Drain pans shall be insulating mastic coated Type 304 stainless steel sloped to be self draining so as to pass the following test: Fill the drain pan with water, then allow to drain for two minutes with the unit doors closed and the unit running. There shall be no puddles left in the drain pan larger than 2 inch in diameter or 1/8 inch deep or the drain pan shall not be acceptable.

2.3 ENERGY EXCHANGERS

A. General: Heat exchangers shall be of desiccant wheel construction. No secondary heat transfer surfaces or refrigerants shall be allowed. Minimum requirements which must be clearly indicated in the submittals are:

1. Performance: Energy exchange and pressure drop performance shall be certified by an independent testing agency to operate as scheduled in accordance with the latest edition of ASHRAE Standard 84 - Method of Testing Rotary Air to Air Heat Exchangers. Provide certified published catalog curves for heat exchanger efficiency and pressure drop for a full range of mass flow, temperature differential, and exhaust humidity. Computer generated performance data may be used as a supplement only. Minimum effectiveness scheduled shall be steady state or averaged at design conditions, rather than transient peak operating efficiency of a newly defrosted exchanger. Heat exchangers shall not use cycling of OA as a frost protection strategy. Minimum exchanger surface area shall be as required to meet the energy exchange and pressure drop performance criteria scheduled.

2. Maintenance Provisions: Entire transfer surface for all four (4) exhaust and supply sides of each exchanger must be accessible for inspection and cleaning through access doors, without requiring removal of casing panels. Entire heat exchanger module must be removable for maintenance by removal of casing panels without requiring removal of unit framing.

3. Field Testing: Test thermal and pressure performance in the field after the airflow balance is completed, as part of the testing and balancing work. This will be used to verify the submittal performance curves, and will be the basis of performance warranty claims.

4. Rotary Wheel Heat Exchangers:

   a. Enthalpy recovery rotary wheel systems shall incorporate a removable cassette to facilitate maintenance, of segmented construction for wheels 96” in diameter and larger.

b. Rotor shall be mounted on a structural framework using press fit sealed ball bearings or relubricable pillow block or flanged ball bearings, with flexible copper or plastic lubrication lines extended to point of access on drive access side of unit with zerk fittings rigidly attached to drive-side bearing support.

c. Rotor drive system shall include fractional horsepower motor driven by a variable speed drive, connected to wheel through a reducing gear box and 2" pitch diameter minimum drive pulley with a v or multi-v belt encircling the wheel perimeter. Wheel perimeter speed shall not exceed 400fpm.

d. Seals and purge sector shall be of a design that eliminates wheel surface scoring and limits cross contamination between supply and exhaust airstreams to less than 0.05% (five one hundredths of one percent). Provide a factory set field adjustable purge sector to limit cross contamination, and include effects of purge sector flow in fan performance and wheel effectiveness requirements.

e. Wheel media shall be alternate layers of flat and corrugated energy recovery media, of either aluminum with a surface bonded silica gel desiccant or fibrous synthetic with an impregnated desiccant and shall be rated by the manufacturer for repeated washing with either low pressure steam or hot detergent water solution with negligible loss of latent effectiveness. Aluminum wheels with a surface oxide desiccant coating shall not be permitted. Desiccant may incorporate a molecular sieve prohibiting passage of gas molecules equal to or larger than 4 angstrom, but at no relaxation of specified effectiveness.

2.4 BLOWER/MOTOR ASSEMBLIES

A. Blower Assembly Mounting: Blower assemblies shall be mounted on a structural steel frame, not lighter than 12 gauge, supported by restrained spring vibration isolators designed for minimum 2 inch static deflection and 90-98 percent isolation efficiency, which in turn shall be mounted on a structural extension of the unit frame. Blower inlets/outlets shall be flexibly connected to the unit casing. Steel frame, drives, isolators, unitary bases, and motor bases shall be coated with rust preventative coating for corrosion protection.

B. Blowers: Supply and exhaust air blowers shall be single inlet, single width, low speed type plenum construction with airfoil blade backward inclined centrifugal impellers. Blowers shall be of the size, performance, and efficiency scheduled at minimum. Blower performance shall be tested and certified according to AMCA Standard 210 and/or AHRI Standard 430-89. Impellers shall be direct drive motor mounted. Direct drive blowers shall not operate at above the motor nameplate nominal RPM at 80 Hz at the design conditions but shall be rated to be driven at least 10% over design RPM as required to accommodate field conditions. Fan shafts shall be sized so as to not exceed 75% of their first critical speed at any cataloged rpm. The shaft shall be coated with a rust inhibitor and supported by two L-50 200,000 hr split or self-aligning pillow block bearings. The rotating assembly shall be dynamically balanced at maximum non-overloading rpm minimum after being installed in the factory assembled section, prior to shipment.

C. Motors: Motors shall be 1800 RPM (or other rpm coordinated with the blower wheel if direct drive), 3 phase, voltage as called for on the plans, coordinated with electrical power distribution available, continuous heavy-duty cast-iron construction, premium efficiency, TEFC, standard NEMA frame, and shall have a 1.15 service factor. Motors shall be of inverter duty design meeting NEMA MG-1, Part 31, rated for pulse width modulated variable frequency drive service with Class F insulation system and Class F thermostats (one per phase). Direct drive motors shall have premium bearings rated for L-50 200,000 hr life at the connected lateral and axial loads and shall be rated for continuous operation at up to 90 Hz under variable frequency drive control.

D. Maintenance: Blowers and drives shall be accessible from access doors (access panels not acceptable). Frame and casing construction shall allow removal and replacement of the blowers. Provide internal personnel guards (with tachometer holes for motor and blower shafts) surrounding shafts, and fan wheels. Provide lubrication lines extended to point of access outside guard.

E. Variable Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

2. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

3. Unit Operating Requirements:

    a. Input ac voltage tolerance of 208 V, plus or minus 5 percent.
    b. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
    c. Minimum Efficiency: 96 percent at 60 Hz, full load.
    d. Minimum Displacement Primary-Side Power Factor: 96 percent.
    e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
    f. Starting Torque: 100 percent of rated torque or as indicated.
    g. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

5. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: 2 to a minimum of 22 seconds.
    d. Deceleration: 2 to a minimum of 22 seconds.
    e. Current Limit: 50 to a minimum of 110 percent of maximum rating.

6. Self-Protection and Reliability Features:

    a. Input transient protection by means of surge suppressors.
    b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
    c. Adjustable motor overload relays capable of NEMA ICS 2, Class 20 performance.
    d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
    e. Instantaneous line-to-line and line-to-ground overcurrent trips.
    f. Loss-of-phase protection.
    g. Reverse-phase protection.
    h. Short-circuit protection.
    i. Motor overtemperature fault.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

8. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

11. Door-mounted LED status lights shall indicate the following conditions:

    a. Power on.
    b. Run.
    c. Overvoltage.
    d. Line fault.
    e. Overcurrent.
    f. External fault.

12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.

13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

    a. Output frequency (Hertz).
    b. Motor speed (rpm).
    c. Motor status (running, stop, fault).
    d. Motor current (amperes).
    e. Motor torque (percent).

f. Fault or alarming status (code).
g. Proportional-integral-derivative (PID) feedback signal (percent).
h. DC-link voltage (volts direct current).
i. Set-point frequency (Hertz).
j. Motor output voltage (volts).

14. Control Signal Interface:

    a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

    b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:

        1) 0 to 10-V dc.
        2) 0-20 or 4-20 mA.
        3) Potentiometer using up/down digital inputs.
        4) Fixed frequencies using digital inputs.
        5) EIA-485.
        6) Keypad display for local hand operation.

    c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hertz).
        2) Output current (load).
        3) DC-link voltage (volts direct current).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hertz).

    d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

        1) Motor running.
        2) Set-point speed reached.
        3) Fault and warning indication (overtemperature or overcurrent).
        4) High- or low-speed limits reached.

15. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

17. Accessories:

    a. Devices shall be factory installed in controller enclosure unless otherwise indicated.

b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

c. Standard Displays:

1) Output frequency (Hertz).
2) Set-point frequency (Hertz).
3) Motor current (amperes).
4) DC-link voltage (volts direct current).
5) Motor torque (percent).
6) Motor speed (rpm).
7) Motor output voltage (volts).

2.5 COILS

A. Provide unit casing of sufficient size for a service compartment with ample room for all coil connections, specialties, and service access within the (rectangular) unit casing and behind an access door. Seal field piping penetrations of unit casing with flexible elastomeric deck piping penetrations similar to Pate pipe seals.

B. General:

1. Size for face velocity and maximum pressure drops scheduled. If not scheduled, size to provide maximum of 500 fpm face velocity for cooling coils, 650 fpm face velocity for heating coils, or higher only if restricted by maximum coil size that can fit within existing units.

2. All coils to be computer optimized as to size and arrangement to meet requirements listed on drawings. Include computer selection sheets in submittal.

3. Certified in accordance with AHRI Standard 410.

4. Rate coils for the type and percentage of glycol solution called for, where applicable.

C. Hydronic Heating Coils:

1. Coils shall have all performance characteristics as scheduled or otherwise required as a minimum, including size, capacity, number of rows, tubing and circuits, headers, connection sizes, and water and air pressure drops.

2. Casings: Constructed of 16 gauge channels with fins tight against or recessed into the channels to minimize air bypass. Channels to have 3/8" holes on 6" centers for flanged to duct mounting. Where required by different existing duct connection conditions, provide flange mounting arrangement to match existing.

a. Heating coils shall have continuously galvanized steel casing frames.

3. Headers:

a. Provide copper, steel, or cast-iron headers as required to achieve capacity, even discharge air temperatures, and water pressure drop scheduled.

1) Seamless extra heavy wall copper tubing with brazed brass threaded supply and return connections.

2) Gray cast iron hydrostatically tested to 400 PSIG before assembly. Headers 12 inch and larger shall be tapered to assure uniform distribution to all tubes. Provide threaded or flanged connections.

3) Provide system connection sizes same size as connected piping as shown on drawings, unless otherwise scheduled.

4) Provide drain and vent connections in headers.

4. Tubes, unless otherwise scheduled:

a. Seamless, 5/8" O.D., 0.024 inch min. wall copper tube primary surface, expanded into the fin collars for a permanent fin tube bond and brazed copper header into the header for a leak tight joint at 250 PSIG air pressure under water.

b. Return bends shall be .035" min. wall machine die formed and wrinkle free at the bend I.D.

5. Fins:

a. Continuously configured .006" min. plate type fins with full fin collars for accurate spacing and maximum fin - tube contact.
b. Heating coil fin material: aluminum.

6. The complete coil core shall be tested with 315 psi min. air (or nitrogen) pressure under warm water and guaranteed for 250 psig working pressure.

7. Bronze spring type turbulators shall be used where necessary to attain required capacity at the available GPM and entering water temperature, without increase in scheduled water pressure drop.

2.6 DAMPERS

A. All dampers shall be of low leakage opposed blade (unless otherwise required and approved) design AMCA rated for less than 6 cfm leakage per square foot at 4 inch wc. Damper frames shall be fabricated of extruded aluminum channel sections with reinforced corner bracing, shall have compressible metal jamb seals, shall be separated from dissimilar metal casing by dielectric gasketing, and shall be fastened to the unit casing by approved stainless steel fasteners. Blades shall be of extruded aluminum airfoil construction, mounted on zinc coated square or hexagonal steel shafting operating in stainless steel or approved polymer sleeve bearings. Linkage shall be corrosion resistant coated and concealed in the frame outside of the air stream. Damper actuators shall be electric modulating spring return type, design make; Belimo Model AF or NF as required by torque. Damper seals shall be extruded vinyl with air stream inflatable double edges, mechanically locked in extruded blade slots, and easily field replaceable. Dampers shall be Ruskin Model CD-50 or equal. Unit to include:

B. Exhaust Air Exit Damper: Provide parallel blade two position damper with spring return to closed position.

C. Outside Air Inlet Damper: Provide parallel blade modulating damper with spring return to closed position.

D. Recirculation Air Damper: Provide opposed blade type with spring return to closed position modulating operator.

E. Triple Deck Multi-Zone Damper Assembly: Provide factory mounted multi-zone dampers serving the hot deck, the bypass deck, and the cold deck. Configure dampers to provide individual zone control with a single factory mounted and wired actuator per zone. Each zone's cold deck blade and hot deck blade shall be connected to a neutral deck blade via a single spring loaded shaft. In no case will air from the cold deck mix with air from the hot deck. The cold deck, bypass deck, and hot deck are separated by double-wall insulated dividers. Damper shafts are mounted in permanently lubricated nylon bearings to assure smooth operation. Damper blades operate without clatter or binding.

2.7 FILTERS

A. Unit shall have pre-filters before the outside air and exhaust air faces of the heat recovery core, and final higher efficiency filters, on the positive pressure side of the supply air stream where possible. Pre-filters may be mounted in a face mount filter rack or side access slide type filter rack with filter pull strips. Final filters to be mounted in a gasketed and spring clip secured face mount filter rack. Maximum face velocity 300 fpm for all filters or as otherwise scheduled.

B. Provide 2 in. pleated MERV 8 (minimum) pre-filters.

C. Provide 4" deep pleated MERV 13 (minimum) final filters.

2.8 ELECTRICAL

A. All power and control components shall be fully wired, factory tested as a unit, and ETL listed as a complete package under Category 169, Heating and Cooling Equipment, prior to shipment. Include verification in the submittal. ETL listing of only the control panel is not acceptable.

B. Provide UL listed power components. Wire all power and controls per NEC, enclosed in liquid tight conduit, all connections internal to the unit casing in NEMA type 12 enclosures. Provide externally mounted NEMA 12 main non-fused disconnect as a single point of electrical power connection.

C. Provide auxiliary power components factory wired through transformers, over-current protection and separate disconnect as required back to main unit disconnect such that auxiliary power can be live when main disconnect is shut down for servicing.

1. Provide externally mounted weatherproof 120VAC GFCI convenience outlet.
2. Provide for switched controls power.

D. Provide field mounting and wiring of all controls, damper actuators, and controls sensors. All controls shall share an open BACnet (MSTP or IP) communications protocol with the Building System Controls (BSC) specified in Division 23 Section "Instrumentation and Control For HVAC" as required for full seamless two-way communication and control of all points. Sensors shall be in at least the following locations:

1. Temperature sensors in the return air stream, at each of the inlet and outlet faces of the heat exchanger, and in the supply air stream after the supply blower.
2. Differential pressure sensors across each filter bank.
3. Air flow measuring stations installed in the outside air intake stream.
4. Refer to control schematics on each building _M700-series drawings for additional requirements.

E. Provide an integral NEMA 4 (exterior door) with hinged access doors and an approved locking device. Factory install unit power wiring through control panel to power disconnect, and controls wiring to single terminal block point of connection in panel, for controls wiring connections to remote building controls system. The control panel shall be sealed air tight. The control panel shall be ETL labeled and in accordance with UL-508. The control panel shall contain:

1. Power wiring: main non-fused disconnect as a single point of electrical power connection, wired through starters/contactors or VSCs with 3-phase thermal overload protection to all loads.

2. Controls wiring: control wiring service switch, transformer, circuit fuse, relays, and terminal blocks for factory mounted controls connections.

3. Unit controllers: Provide controllers in full accordance with controls specified in Section 23 09 00, by TCC or unit manufacturer, factory mounted, wired and adjusted as required to provide sequence of operations specified.

4. Information: provide waterproof wiring diagrams adhered to door in the panel. Provide full operating and maintenance instructions with each unit.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with the stricter of these contract documents and the manufacturer's recommendations.

3.2 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.3 OUTDOOR INSTALLATION

A. Install curb in proper position on roof, and secure curb base to roof framing with anchor bolts, secured and leveled as recommended by manufacturer and in accordance with Division 23 Section on "Hangars and Supports for HVAC Components". Provide warranted weather tight installation.

B. Install equipment on curbs and coordinate roof penetrations and counter-flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure equipment to upper curb rail as recommended by manufacturer and in accordance with requirements for seismic and wind load restraint system.

C. Pipe coil drain pans to drain to roof through properly sized p-trap(s).

D. Install units with clearances for service and maintenance.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Provide freeze protection circuitry as more fully described in SECTION 23 09 00 - Instrumentation and Control for HVAC.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

E. Hydronic Piping: Comply with applicable requirements in Division 23 Sections on "Valves" and "Hydronic Piping". Install shutoff valve and union or flange at each coil connection within roof top unit as required to facilitate ease of coil removal and service. Install balancing valve and union or flange at each coil return connection.

F. Install ducts to termination at top of roof curb. Comply with requirements for ductwork specified in Division 23 Section "Ductwork." Remove roof decking only as required for passage of ducts and piping. Do not cut out decking under entire roof curb.

G. Electrical Connections: Comply with applicable requirements in Division 26 Sections.

1. Install electrical devices furnished with units but not factory mounted.

3.5 FIELD QUALITY CONTROL AND STARTUP SERVICE

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for damage and completion and repair as needed to provide complete undamaged units:

    a. Inspect for visible damage to unit exterior: frame, casing, doors, hoods, rigging points, etc.
    b. Inspect for visible damage to unit interior: compressor, coils, internal insulation, and fans.
    c. Inspect for proper connection of piping, ducts, electrical power, and drains.
    d. Verify that labels are clearly visible.
    e. Verify that clearances have been provided for servicing.
    f. Verify that filters are installed.

2. Check all wiring circuits.

    a. Measure and check voltage of components.
    b. Adjust variable speed motor controllers.
    c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3. Check and adjust fans:

    a. Remove packing from vibration isolators and adjust to provide proper vibration isolation and movement control.
    b. Verify lubrication on fan and motor bearings.
    c. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
    d. Check fan RPM, motor amps, rotation, etc.

4. Check and adjust Energy recovery components:

    a. Adjust energy recovery wheel seals and purge angle to minimize leakage and cross-contamination.
    b. Adjust wheel drive system and VSD for proper operation. Coordinate freeze protection strategies with controls subcontractor.
    c. Check for spare belts.

5. Check and adjust controls:

   a. Verify that controls are connected and operable.

   b. Test and adjust controls and safeties operation and performance during all modes of operation. Replace damaged and malfunctioning controls and equipment.

   c. Inspect and record performance of interlocks and protective devices; verify sequences.

   d. Test and adjust all control loops and variables as required to provide smoothly modulated temperatures, for the hot and cold decks, for the mixed air temperature, for all discharge temperatures, and especially for all affected space temperatures. Tune loops during both cooling and heating modes as well as economizer and changeover modes until full space comfort is observed and agreed to by Owner.

   e. Inspect dampers for proper stroke and closure.

   f. Set initial temperature and humidity set points.

   g. Adjust and inspect high-temperature limits.

6. Operate unit for an initial period as recommended or required by manufacturer, and verify that building energy management controls properly operate unit automatically in all required modes.

7. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units. Demonstrate unit operation and system interface, and describe control features in person and in writing to the Owner’s representatives. Provide instruction on maximizing the unit’s effectiveness at lowering the Owners’ energy use.

END OF SECTION 23 74 13

SECTION 23 82 00 – TERMINAL HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of Terminal Heating and Cooling Equipment, associated accessories, and their installation:

1. Unit Ventilators (UV),
2. Fan-Coil Units (FCU),
3. Cabinet Unit Heaters (CUH),
4. Fin Tube Radiation (FTR),

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Provide emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate layout and installation of all units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake and relief dampers.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Unit Ventilator Filters: Furnish two spare filters for each filter installed.
2. Fan-Coil Filters: Furnish two spare filters for each filter installed.
3. Cabinet Unit Heater Filters: Furnish two spare filters for each filter installed.

PART 2 - PRODUCTS

2.1 UNIT VENTILATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Corporation.
2. Daikin.
3. Magic Aire
4. Trane.

B. Description: Factory-packaged and -tested units rated according to AHRI 840, ASHRAE 33, and UL 1995, including finished cabinet, dampers, filter, heating coil, supply-air fan and motor in blow-through configuration.

C. Provide Unit Ventilators constructed to operate quietly in an exposed classroom environment. Cabinet construction, fan speed and quality, and system insulation shall all combine to create units that operate with sound levels that do not exceed those shown below.

Unit Size	Motor Speed	SOUND POWER DATA (db re: 10^{-12} watts)						
Octave Band:		*2*	*3*	*4*	*5*	*6*	*7*	*8*
Center Frequency:		*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*
a. 750	High	57.4	51.8	52.5	52.6	51.2	46.9	35.2
b. 750	Medium	50.1	44.9	45.6	44.8	42.8	34.2	19.9
c. 750	Low	45.6	40.4	40.8	39.1	35.7	24.4	12.0

D. Cabinets

1. Frames: jig welded of heavy gauge steel to insure proper durability, dimensions, and squareness.

2. Finish: sheet metal parts of G-90 galvanized steel to inhibit corrosion, exterior cabinet panels fabricated from 16-ga. Furniture grade galvanized steel, cleaned and phosphatized before applying a baked on polyester powder coat enamel finish. Finish color to be selected by Architect from manufacturer's standard colors.

3. Insulation: Minimum 1-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

   a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

   b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in NFPA 90.1 and ASHRAE 62.1.

4. Service Access:

   a. Opening or removing the unit front control and service panels shall not affect unit operation, allowing controls and damper linkage adjustments while the unit is running.

   b. Provide hex-head fasteners designed for repeated use to secure all removable panels.

5. Provide heating only units with coil mounting configuration and drain pan such that the later addition of a cooling coil requires no chassis modification.

E. Floor Units:

1. Provide with three separate removable front panels configured so that it is not necessary to remove the entire unit front cover or disturb the airflow to gain access to the service and control compartments.

2. Provide an integral closed rear pipe tunnel for convenient crossover of piping or electrical wiring in accordance with NEC.

3. Provide with supply discharge grille of continuous round edged steel bars with 10 to 15 degree vertical deflection and adjustable side deflection vanes beneath the discharge grille.

4. Return-Air Inlet: Front toe space.

5. End Panels: Provide formed steel end panels nominally 1” deep.

6. Provide 1/4” mesh screen beneath the discharge grille to protect against objects being dropped through the discharge grille.

7. Provide leveling legs to compensate for uneven floor surfaces.

8. Provide adaptor back units (21-7/8") consisting of standard depth unit plus approximately five inch deep insulated false back outside air intake plenum wherever manufacturer’s standard size OA intake opening in general construction is not directly aligned with unit OA intake and unless standard depth units are specifically called for.

    a. Provide insulation on the rear of the basic unit same as the standard depth unit.

    b. Include full back panel with field cut flanged opening to match wall opening.

    c. Provide dual closed cell foam gasket at rear of the adaptor back as required to provide air tight seal round the wall opening and the unit perimeter when the unit is lagged to the wall.

    d. Insulation:

        1) Provide R-6 minimum, matte-finish closed-cell foam insulation, complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Insulate outside air duct on bottom, side, and top walls of adapter back and pipe tunnel as thermal break between outside air intake plenum and occupied space / return air / pipe space.

        2) Fire-Hazard Classification: Insulation and adhesive combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

        3) Surfaces in contact with the airstream: Comply with requirements in ASHRAE 62.1.

9. Provide a durable Charcoal Bronze textured paint finish on the top surface. Provide front end, and all other visible panels with baked enamel finish available in a minimum of (6) decorator colors for selection by the Architect.

F. Coils:

1. Test and rate unit ventilator coils according to ASHRAE 33.

2. Steam Coils: Double copper tube steam distributing freeze resistant type sloped for drainage, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig. Provide a pressure-equalizing device (vacuum breaker) factory installed to prevent the retention of condensate in the coil, complete with tubing for connecting the equalizing device to the condensate return line beyond the trap.

3. Coil Accessories:

   a. Provide a factory installed automatic reset freeze-stat (refer to section 23 09 00 for specification) serpentined across the discharge face of the coil. Install tautly extended across and in close proximity to representative areas of coil as required to insure and guarantee against coil freeze-up conditions without freeze-stat nuisance trip.

G. Dampers

1. Provide with separate room air, outdoor air, and coil face and bypass air dampers.

   a. Damper shaft extends through bearings to service compartment designed to accept electronic damper actuator.
   b. Bearings of high-performance polymer similar to delrin which does not require lubrication.
   c. Seals along edges of formed damper blade material fitted into channel with blended silicone rubber and mohair impregnated glass cloth, with mohair seals along all ends.

2. Room air damper: constructed of aluminum, counterbalanced against back pressure to close by wind pressure, thereby positively preventing outdoor air from blowing directly into the room.

3. Outdoor air damper: two-piece double wall torsionally rigid box beam construction with 1/2" thick, 1.5pcf density fiberglass sandwiched between welded 20-ga. galvanized steel blades. Provide additional closed cell foam insulation adhered to the interior and exterior of the outside air dampers and all other surfaces of the outside air chamber, minimum R value of 4.

4. Face and bypass damper: double wall torsionally rigid box beam aluminum construction with a dead air space.

H. Indoor Fan and Motor Assembly

1. Direct drive multiple fan and motor assembly constructed to assure quiet, uniform air distribution, guaranteed to deliver the unit's nominal advertised cfm at high speed.

2. All components of the fan/motor assembly including the motor mounting platform mounted on a chassis removable as a single subassembly from the front of the unit.

3. Fans wheels statically and dynamically balanced, constructed of welded galvanized steel or dark, high density, injection molded fiber reinforced polypropylene having high impact strength, chemical resistance and thermal stability. Fan housings constructed of welded galvanized steel, with deep spun bell-mouth entries.

4. Single full length large diameter hollow steel shaft on resiliently mounted precision shaft end sleeve type bearings. Bearings require oiling no more than annually, located outside of the moving air stream with no intermediate bearings allowed.

5. Motors designed specifically for extra quiet unit ventilator operation, 115 volts, single phase 60 Hz unless otherwise scheduled.

    a. Automatic speed control motors: electronically commutated motor (ECM). Motor shall be of permanent magnet, brushless DC premium efficiency design with variable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball bearings, and extra quiet operation are all included.

I. Unit Electrical and Controls

1. Provide unit mounted integral disconnect and control boxes with ample room for installing and servicing controllers, control circuit fusing, room air fan speed terminal contacts for ECM motor control by DDC control system, speed selector switch as applicable, freeze-stat switch body, transformers, and fused 120vac duplex outlet. Arrange all electrical components for ease of serviceability.

2. Provide fan motor and controls voltage power transformers for units where power source is other than fan and/or controls voltage.

3. Provide additional fused 120vac duplex outlet, to be available for power supply to control components and for servicing. Wire this outlet receptacle so that whenever the unit ventilator fan power disconnect is turned off, power is still supplied to this controls power outlet. Provide warning signage at receptacle stating it has power when disconnect is off, or, provide second disconnect.

4. Additional control devices and operational sequences are specified in Division 23 Section "Instrumentation and Control for HVAC" and on the drawings.

J. Accessories

1. Sub-base: Sheet metal floor-mounting base with leveling screws and black enamel finish.

2. Filters: Minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

    a. 1 inch thick mini-pleated cotton-polyester media MERV 13 filters have a rating based on ASHRAE Standard 52.2.

3. Outside Air Intake:

    a. Provide outdoor air intakes of vertical blade louver design, of aluminum construction, 2-1/4" deep in the direction of the air flow, with weep hole along bottom edge for drainage.

    b. Provide 1/2" x 1/2" bird screen on inside face of louver, and 12 gauge aluminum outdoor protective grille with square holes of spacing to match louver blades, connected by 1/4” wide frets aligned with louver blades to minimize intake air obstruction.

c. Provide scheduled factory finish as detailed below.

1) Kynar: Provide factory applied and baked resin based paint coating, minimum 70% fluoropolymer (PVDF) similar to Kynar 500 or Hylar 5000 as manufactured by the Valspar Corporation. Coating shall meet all performance requirements of AAMA 2605 and ASCA 96. Color as selected by Architect from manufacturer's full range of standard or premium colors including minimum 16 "standard" colors and 12 "premium" colors.

d. Provide galvanized sheet metal OA intake sleeve from louver to unit back complete as detailed and as required to effect airtight seal to unit, in accordance with specification section 23 31 00 –Ductwork.

e. Provide intakes by unit ventilator manufacturer except as otherwise noted on the Drawings. Provide manufacturer's standard size intake for that size UV unless indicated otherwise on drawings.

2.2 FAN-COIL UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Corporation.
2. Environmental Technologies, Inc.
3. McQuay International.
4. Trane.
5. YORK International Corporation.

B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1/2-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

E. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Vertical Unit Front Panels: Removable, steel, with integral stamped steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.

F. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

1. Louver Configuration: Horizontal, rain-resistant louver.

2. Louver Material: Aluminum.
3. Bird Screen: 1/2-inch mesh screen on interior side of louver.
4. Decorative Grille: On outside of intake.
5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.

G. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with shaft ready to accept electronic actuators.

H. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. 1 inch thick mini-pleated cotton-polyester media MERV 13 filters have a rating based on ASHRAE Standard 52.2.

I. Steam Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig.

J. Fan and Motor Board: Removable.

1. Size / design for mid-life filter resistance equal to the average of the as specified clean filter resistance at the design flowrate and the filter manufacturer’s recommended maximum (in need of changing) filter resistance at the design flow rate.

2. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

3. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Electrical Requirements for HVAC Equipment."

4. Wiring Termination: Connect motor to chassis wiring with plug connection.

K. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC".

L. Electrical Connection: Factory wire motors for a single electrical connection. Provide factory mounted unit disconnect.

2.3 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Corporation.
2. McQuay International.
3. Trane.

B. Description: A factory-assembled and -tested unit complying with AHRI 440.

C. Coil Section Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch- thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.

2. Horizontal Unit, Concealed: Minimum 0.0677-inch- thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain, fitted with duct collar inlets and oulets.

3. Control Access Door: Key operated.

4. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: 90 percent arrestance and 7 MERV.

F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

G. Steam Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 75 psig.

H. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Electrical Requirements for HVAC Equipment."

3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

I. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC".

2.4 HOT-WATER OR STEAM FINNED TUBE RADIATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Rittling, a div. of Hydro-Air Components.
2. Slant/Fin.
3. Sterling Hydronics, a Mestek company.

B. Performance Ratings: Rate baseboard radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

C. Fin Radiation: Complete enclosure of heavy-duty, institutional grade construction, continuous supporting channel and back plate, heating element, hangers and accessories as required; factory-boxed and tagged by room number and securely anchored to building in a manufacturers approved manner. Enclosures to run from wall-to-wall, unless otherwise indicated on Drawings, and provided with all necessary corner pieces, end caps, column enclosures, butt joint trims, wall sleeves, and all access doors required.

1. Heating Elements:

a. Element constructed of seamless drawn copper tubing mechanically expanded into aluminum full collar or full temper embedded fins of size shown and specified.

b. Provide tube size 3/4” through 1-1/4” as required by flow rate. Use same fin tube element tube size as pipe size shown leading to fin tube on drawings.

c. Provide elements in lengths, sizes, and capacities as shown on drawings.

1) For all fin tube provide element with forty 3-1/4” x 3-1/4” aluminum fins per foot with bare single element nominal capacity of 680 btu/ft-hr. at 65 deg. F entering air temperature and hot water at EWT 180 deg. F, LWT 160 deg. F.

2. Fin Tube Element and Enclosure types:

a. Type B: Wall mounted slope top enclosure nominally 4-1/4” deep x 18” high (unless noted otherwise), with stamped slotted sloped front supply grille.

3. Element Supports: Swinging, ball bearing, or sliding type designed to allow for expansion. Supports must allow free noiseless movement of pipe and elements.

4. Enclosures:

a. Complete enclosures to run from wall-to-wall unless otherwise shown and noted on plans.

b. Materials:

1) General service: ASTM A-653/653M-94 G90 lock forming quality galvanized steel, prepared for painting via mill phosphatizing in accordance with ASTM A2092, unless otherwise noted.

c. Material gauges:

1) 14 ga.: Cafeteria service.

d. Provide continuous enclosure back plate and back hanger channel of 20 ga. roll formed material same as cover, configured for positive support of cover and element. Include continuous urethane foam dirt seal between wall and channel.

e. Gusset braced cover construction with stamped outlet and inlet of configuration described above. Provide cover support brackets spaced as recommended by manufacturer but on center distances not greater than 4'. Provide brackets within 6" of end of cover and within 6" (on both sides) of each joint between sections or corner joints. All fasteners shall be concealed or tamper resistant. Fasteners shall match enclosure materials.

f. Provide matching die formed end caps, inside and outside corner pieces, wall sleeves, internal end plates, column enclosures, butt strips, valve compartments, riser chases, access doors and other accessories as shown on drawings and as required to fabricate neat, complete installation.

g. Enclosures and all trim accessories shall be phosphatized and painted inside and out with one coat of baked on alkyd enamel primer, then finished with baked enamel in color selected by Architect.

5. Valve Access Panel:

a. 12" wide minimum, full enclosure height access door with tamper resistant closure. Provide for reasonable service access where any of the following must be within enclosure (typical):

1) Isolation valve.
2) Air vent or drain.
3) Shut off valves, unions, P/T plugs, etc.
4) Temperature control valve.

b. Alternatively, provide nominally 24” wide section of enclosure at location of piping specialties, with tamper resistant fasteners designed and installed to facilitate ease of repeated maintenance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install equipment in compliance with NFPA 90A.

B. Install equipment level and plumb.

C. Suspend motorized equipment from structure with threaded steel rods and minimum 0.25-inch static-deflection, elastomeric vibration isolation hanger. Vibration isolators are specified in Section 23 05 43 "Mechanical Vibration and Movement Control."

1. Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of 3.

3.3 FREEZE-PROTECTION

A. Take all precautions to prevent uncontrolled infiltration of outdoor air to coils and piping, including (but not necessarily limited to) following preventative steps:

B. Provide sleeves, safing, insulation, caulking, etc..., as required to make neat and airtight connection to outside air intakes, with no uncontrolled infiltration permitted.

C. If walls are in such condition that it is impossible to plumb the units with the walls and get correct sealing through standard methods, notify the Owner and Architect of proposed solution, and modify methods as required. Units must seal tightly against the walls and prevent infiltration.

D. Insure that adapter back wall boxes are properly installed and sealed and that no air is permitted to leak past them. Insulate per section 23 07 00 – HVAC Insulation.

E. Adjust outdoor air dampers on the units to close tightly when in the unoccupied position (100% closed).

F. All openings in the outside air intake path between the intake louver and the outside air control damper which could permit the uncontrolled entrance of outdoor air shall be sealed and insulated. This includes but is not limited to unused holes (knockouts, etc.,), spaces around pipes and conduits, sealing wall sleeve to wall, sealing around intake louver, and other openings into piping and air compartments.

G. Insure that all freeze protection controls are in place and functional prior to freezing weather. During initial freezing weather, man job and continuously inspect for freeze concerns, provide report to Architect and Owner immediately and correct any discovered conditions which may result in freeze damage.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
3. Connect piping to equipment using specialties as detailed on drawings, with at minimum isolation valves, unions, and P/T test ports supply and return, with control valve on return as specified.

B. Ground and wire equipment according to the stricter of manufacturer's and Division 26 requirements.

3.5 FIELD QUALITY CONTROL

A. Ensure Manufacturers provide:

1. Thorough instruction of installing Contractor's personnel in installation of units.

2. Instruction for Owner's personnel in operation and care of equipment.

3. Maintenance brochure.

4. Adjustment of air discharge pattern to suit each room as directed and approved.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

D. After installing equipment, inspect for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

E. Remove and replace malfunctioning and damaged units and retest as specified above.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 82 00

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SUMMARY

A. Section Includes:

1. General requirements applicable to components and systems included in Electric Contract.

B. Products Installed but Not Furnished Under This Section

1. Make electrical connections to equipment shown on Drawings and furnished by other Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Contractor furnishing equipment.

1.3 REFERENCES

A.	AIA	American Institute of Architects
B.	ADA	Americans with Disabilities Act
C.	AISC	American Institute of Steel Construction
D.	ANSI	American National Standards Institute
E.	ASTM	ASTM International
F.	IBC	International Building Code
G.	IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
H.	IES	Illuminating Engineering Society of North America
I.	NEC	National Electrical Code
J.	NEMA	National Electrical Manufacturers' Association
K.	NETA	International Electrical Testing Association
L.	NFPA	National Fire Protection Association
M.	UL	Underwriters' Laboratories, Inc.

1.4 SYSTEM DESCRIPTIONS

A. Inspection of Existing Systems: Inspect each existing system scheduled for modification in presence of Authorized Owner's Representative and issue a deficiency report to Owner and Architect listing conditions found prior to any removals, relocations, or additions. Modified systems include (but are not limited to):

1. Power distribution.
2. Lighting.
3. Emergency lighting.

B. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):

1. Wiring and raceway for work specified in Project Manual and shown on Drawings.

2. Electrical devices and equipment for work specified in Project Manual and shown on Drawings.

3. Systems included, but not limited to:

a. Electrical distribution.
b. Electrical connections.
c. Lighting.
d. Emergency lighting.

C. Electric Layouts: Arrange panels; disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch fire treated, gray painted plywood backboards for surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.

D. Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Owner. Confirm with Owner prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

1.5 SUBMITTALS

A. General Division 26 submittal requirements:

1. Comply with requirements of SECTION 01 33 00 – SUBMITTAL PROCEDURES and as modified below.

2. Product Data: Submit product data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.

a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under the same cover sheet.

b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data and, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in the "Part 2 – Products" of each technical section.

3. Shop Drawings: Submit detailed drawings for electrical equipment layouts, showing exact sizes and locations for approval before beginning work.

   a. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.

   b. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space other pertinent revisions to arrangement and configuration shown in Contract Documents.

4. Samples: On all submittals, indicate standard factory color and factory finish surfaces. Where more than one color is available, selection will be made by Architect from manufacturer's full range of colors. Electronically transmitted color samples are not acceptable.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for penetration firestopping materials. Include ratings, furnished specialties and accessories.

1. Penetration firestopping materials.
2. Penetration firestopping assembly drawings.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Codes and Standards: Comply with applicable Federal, State and local building and electrical codes, laws, ordinances, and regulations, and comply with applicable NFPA, National Electrical Code and utility company requirements and regulations. Provide Underwriters Laboratories Seal on all materials.

2. Permits and Inspections: Obtain approvals, tests, and inspections required by Architect, Engineer, local electrical inspector, agent or agency specified in Project Manual, or National, State, or local codes and ordinances.

   a. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.

b. Furnish materials and labor necessary for tests and pay costs associated with tests and inspections.
c. Conduct tests under load for load balancing and where required by codes, regulations, ordinances, or technical Specification.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.8 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

1. Take precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
2. Replace equipment damaged beyond reasonable repair as required by Architect.
3. Refinish any equipment with marks, stains, scratches, dents, and other aesthetic damage that doesn't impede operation of equipment as required by Architect.

1.9 COORDINATION OF WORK

A. New Construction:

1. Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric Contract systems and components): Coordinate requirements with General Contractor for inclusion in General Contract. Furnish necessary information (e.g. locations and sizes) to General Contractor in ample time for installation of systems and components included in Electric Contract.

2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Contract construction that are to be installed in construction included in General Contract.

3. Locate settings, check locations as installation in General Contract progresses, and provide templates or holding fixtures as required to maintain proper accuracy.

B. Existing Construction:

1. Unless otherwise specified, employ Contractor responsible for General Work for all cutting, patching, repairing, and replacing of general work required for installation of systems and components included in Electric Work. Secure approval from Architect's representative before cutting.

2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Work construction that are to be installed in construction included in General Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

3. Access Doors: Provide access doors shown on Drawings, or as required for access to pull boxes, junction boxes, relays and other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

1.10 ALTERATION PROCEDURES

A. In locations where existing devices are indicated to be disconnected and removed and existing power circuit or communications cable is not scheduled to be reused:

1. Remove circuit conductors back to source.

2. Modify panel directory for that circuit.

3. Remove all existing exposed and concealed accessible raceway.

4. Provide blank cover plates or wall infill (as indicated on plans) and as described below:

a. For single gang and multi-gang switch boxes in public or occupied spaces; stainless steel coverplates.

b. For single gang and multi-gang boxes in un-occupied spaces; stainless steel, galvanized steel or PVC coverplates.

c. For boxes larger than standard switch boxes in public or occupied spaces; remove existing box and provide wall infill, matching existing sub-surface and finished surface conditions. Paint wall to match surrounding finishes.

d. For boxes larger than standard switch boxes in un-occupied spaces; 18 gage galvanized sheet metal coverplate with machined edges. Prime and paint to match surrounding finish conditions.

5. Patch and paint existing walls where disturbed by the electrical work.

B. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain necessary circuitry to existing devices for complete and proper operation.

C. In locations where entire existing system is being removed or modified:

1. Refer to individual system specification sections for documentation and inspection requirements prior to any alteration work on any system.
2. Take all necessary measures to ensure that down time will not compromise safety.
3. Notify Owner, Architect and other Contractors not less than 2 weeks prior to interruptions in service.
4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.

PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

2.2 VAPOR BARRIER PENETRATION

A. Comply with requirements for accessories in vapor barrier penetrations specified in Section 07 27 26 “Fluid-Applied Membrane Air Barriers”.

2.3 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.4 SEALANTS

A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."

B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following::

a. BASF Building Systems; Omniplus.
b. Dow Corning Corporation; 786 Mildew Resistant.
c. GE Advanced Materials - Silicones; Sanitary SCS1700.

2.5 ACCESS DOORS

A. Comply with requirements for access doors specified in Section 08 31 13 “Access Doors and Frames” for product requirements.

2.6 PAINT AND FINISHES

A. Refer to Division 09 for painting and finishing.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Do not cut and vapor barriers or waterproofing for admission of any equipment or materials and do not pierce any structural members without written permission from Architect.

B. Furnish and install sleeves, inserts, panels, raceways, boxes, and similar infrastructure., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.

C. Unless otherwise noted elsewhere in Contract Documents, bear expense of cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Contract or damage done by Electric Contract. Employ and pay Contractor whose work is involved.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of electrical systems and equipment furnished and installed in Electric Contract.

1. System Operator: Maintain competent operator at building for at least 2 days in 2 consecutive weeks after Owner takes occupancy of major parts of building to operate systems and equipment in presence of Owner's representative.

2. Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Owner's representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.

3. Coordinate and schedule time and place of all training through the Architect at the Owner’s convenience.

4. Submit letters attesting to satisfactory completion of instructions, including date of completion of instruction, names of persons in attendance, and signature of Owner’s authorized representative.

5. Architect's representative must be present when Owner's representatives participate in instruction.

3.3 GROUTING

A. Mix and install grout for electrical equipment base bearing surfaces, other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

3.4 SEALANTS

A. Install sealants according to the requirements specified in Section 07 92 00 "Joint Sealants."

3.5 FIRESTOPPING

A. Install firestopping according to the requirements specified in Section 07 84 13 "Penetration Firestopping."

B. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Electrical Work installation.

a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

C. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

3.6 ACCESS DOORS

A. Install access doors according to the requirements specified in Section 08 31 13 "Access Doors and Frames."

END OF SECTION 26 05 00

SECTION 26 05 01 – HAZARDOUS MATERIAL DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SUMMARY

A. Section Includes:

1. Selective removal and subsequent off-site disposal of the following hazardous waste:

   a. PCB containing light ballasts.
   b. Mercury containing fluorescent light tubes.

2. Requirements for transport and disposal of hazardous waste materials by legal and appropriate means.

B. Related Sections

1. Supplementary Conditions: Additional insurance requirements for hazardous waste disposal.

1.3 REFERENCES

A. Regulatory Requirements

1. United States Environmental Protection Agency (EPA)

   a. 40 CFR 260 - Hazardous waste management system: General
   b. 40 CFR 261 - Identification and Listing of Hazardous Waste.
   c. 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste.
   d. 40 CFR 263 - Standards Applicable to Transporters of Hazardous Waste
   e. 40 CFR 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   f. 40 CFR 265 - Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   g. 40 CFR 266 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
   h. 40 CFR 268 - Land Disposal Restrictions
   i. 40 CFR 270 - EPA Administered Permit Programs: The Hazardous Waste Permit Program
   j. 40 CFR 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions.

2. United States Department of Transportation (DOT)

   a. 49 CFR 171 - General Information, Regulations, and Definitions.
   b. 49 CFR 172 - Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
   c. 49 CFR 173 - Shippers - General Requirements for Shipments and Packaging.
   d. 49 CFR 174 - Carriage by Rail.
   e. 49 CFR 175 - Carriage by Aircraft.
   f. 49 CFR 176 - Carriage by Vessel.
   g. 49 CFR 177 - Carriage by Public Highway.
   h. 49 CFR 178 - Specifications for Packaging.
   i. 49 CFR 179 - Specifications for Tank Cars.
   j. 49 CFR 180 - Continuing Qualification for Maintenance of Packaging.

3. New York State Department of Environmental Conservation (DEC)

   a. 6 NYCRR 360 - Solid Waste Management Facilities
   b. 6 NYCRR 364 - Waste Transporter Permits
   c. 6 NYCRR 370 - Hazardous Waste Management System: General.
   d. 6 NYCRR 371 - Identification and Listing of Hazardous Wastes.
   e. 6 NYCRR 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities.
   f. 6 NYCRR 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements.
   g. 6 NYCRR 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.
   h. 6 NYCRR 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waster Facilities.
   i. 6 NYCRR 376 - Land Disposal Restrictions.

1.4 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain Owner's property.

1.5 PROJECT SITE

A. Existing Conditions

1. Building Occupancy: Owner will occupy portions of building immediately adjacent to areas of hazardous material removal operations. Conduct removal operations in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of removal activities that will affect Owner's normal operations.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Labeling and Packaging Materials: Provide labeling and packaging materials as required by 49 CFR 173 Shippers - General Requirements for Shipments and Packaging.

B. Hazardous Waste Disposal Vehicles: Provide vehicles for transporting hazardous waste possessing valid Industrial Waste Hauler Permit and equipped with appropriate placards affixed as prescribed by United States Department of Transportation regulations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which hazardous material disposal is to be conducted and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely hazardous material disposal. Do not proceed with disposal until unsatisfactory conditions have been corrected.

3.2 REMOVAL, PACKAGING, TRANSPORTATION AND DISPOSAL PROCEDURES

A. Removal: Remove light ballasts and fluorescent light tubes whole and intact. Do not release PCBs or mercury to the environment.

B. Packaging: Package, label, and mark all hazardous waste materials in accordance with applicable requirements of 49 CFR 173, 178 and 179.

C. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal to prevent damage or vandalism.

D. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal complying with requirements of 6 NYCRR 372.2 (a) (8). Do not exceed 180 days storage on site.

E. Disposal - Transport hazardous waste to treatment or disposal facility that:

1. Is permitted, licensed or registered by state to dispose of hazardous waste;

2. Has interim status to dispose of hazardous waste;

3. Is authorized to manage hazardous waste under Resource Conservation and Recovery Act (RCRA) or

4. Is facility which:

a. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or

b. Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation.

3.3 ADJUSTING/CLEANING

A. At least weekly, remove from building site debris, rubbish, and other materials resulting from hazardous material disposal operations.

1. If additional hazardous materials are encountered during hazardous material disposal operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.

2. Burning of removed materials not permitted on Project Site.

3. Transport materials removed and legally dispose off-site.

END OF SECTION 26 05 01

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 2000 V and less.
2. Connectors, splices, and terminations rated 2000 V and less.

B. Related Requirements:

1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. VFC: Variable-frequency controller.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

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. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable used in VFC circuits.

E. Conductors: Copper complying with NEMA WC 70/ICEA S-95-658.

1. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2 and Type XHHW-2.

F. Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

1. VFC Cable: Type TC-ER VFD with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

6. Ideal Industries/Buchanan

7. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

a. Conductors No. 8 AWG and smaller: Screw on, wing nut wire connectors with fixed square wire threads and wide throated skirt. UL 486C Listed.

b. Conductors No. 6 AWG to 3/0 AWG: Bolt on type or crimped type compression, seamless copper connectors using hand or hydraulic tool, color coded to wire size. Connector shall be electro-tin plated to resist electrolytic corrosion. UL 486A and UL 486B Listed.

c. Conductors No. 4/0 AWG and larger: Compression type solderless connector, long barrel seamless copper with minimum 2 pressure points per conductor. Fully compatible with industry standard crimping tool-die sets. Color coded to wire size and electro-tin plated to resist electrolytic corrosion. UL 486A Listed.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; stranded.
B. Branch Circuits: Copper, stranded.
C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.
B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.
D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway**.**
E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
F. Feeders in Cable Tray: Metal-clad cable, Type MC.
G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway
H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway
J. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.
K. VFC Output Circuits: Type TC-ER cable with braided shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Wire and Cable Installation: Install all wire and cable in approved raceway with exit light circuits, emergency lighting circuits, and special systems wiring installed in separate raceways. Use UL approved lubricants for wire pulling. Tag all feeders, subfeeders, special system wiring and branch circuit wiring at each pull box, junction box, and gutter space indicating point of origin and termination. Install green grounding wire in all raceways for connection to equipment, motors, transformers, and similar equipment. Install low voltage cables as detailed in individual sections.

B. Splices and Terminations: Make all splices accessible. Insulate all splices, taps, and connections to insulation value of conductor. Follow all instructions and recommendations of splice material manufacturer. Terminate low voltage cables with termination blocks as described in individual sections.

   1. Common Neutral Conductor: Do not use common neutral for multiple branch circuits.

C. Pull all conductors together where more than one is being installed in raceway.

D. Do not exceed maximum pulling tension of wire being installed. Use pulling compound or lubricant, where necessary. Use compound that will not deteriorate conductor or insulation.

E. Use pulling means, including fish tape, cable or rope that cannot damage raceway or wire.

F. Replace wiring damaged during installation.

G. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

H. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

I. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

J. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

K. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

M. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

N. Metal Clad Type "MC" Cable:

1. Install MC cable, parallel and perpendicular to surfaces or structural members following surface contours, where possible.

2. Do not use MC cable for home runs (from panel to first device in branch circuit).

3. Do not install exposed metal clad cable in any areas, including mechanical and electrical spaces.

4. Do not penetrate floor slabs with MC cable.

5. Metal clad cable may be used for switch, receptacle, light fixture, device and fixture branch circuit wiring above ceilings and in walls beyond corridor walls.

6. MC cable shall include a neutral, whether used or not, to a light switch location.

7. Above corridor ceilings, use MC cable for 6 foot light fixture whips.

8. Maintain a clearance of at least 6 inches from hot water and other high temperature pipes and telecommunications conduits, and at least 12 inches from unshielded telecommunications cables.

9. Support MC cable every 6 feet, and within 1 foot of every box, fitting, and cable termination. Do not support MC cable on hung ceilings or on ceiling support wires. The use of cable ties to support MC cable is prohibited.

10. Use MC cable in branch circuit wiring in movable metal partitions and movable gypsum partitions. Install conductors in accordance with partition manufacturer's recommendations.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Splices:

1. Dry Locations:

a. Conductors No. 8 AWG or Smaller: Use spring type pressure connectors or indent type pressure connectors with insulating jackets (except where special type splices are required).

b. Conductors No. 6 AWG or Larger: Use un-insulated indent type pressure connectors. Fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with heat shrinkable splices.

c. Gutter Taps in Panelboards: Install gutter tap, fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with gutter tap cover.

2. Damp Locations: As specified for dry locations, except apply moisture sealing tape over entire insulated connection (moisture sealing tape not required if heat shrinkable splices are used).

3. Wet Locations: Use un-insulated indent type pressure connectors and insulate with resin splice kits or heat shrinkable splices. Exception: Totally enclosed splices above ground protected in NEMA 3R, 4, 4x enclosures may be spliced as specified for damp locations.

E. Terminations:

1. Conductors No. 10 AWG or Smaller - Use terminals for:

a. Connecting control and signal wiring to terminal strips.
b. Connecting wiring to equipment designed for use with terminals.

2. Conductors No. 8 AWG or Larger - Use compression or mechanical type lugs for:

   a. Connecting cables to flat bus bars.
   b. Connecting cables to equipment designed for use with lugs.

3. For Conductor Sizes Larger than Terminal Capacity on Equipment: Reduce larger conductor to maximum conductor size that terminal can accommodate (reduced section not longer than one foot). Use compression or mechanical type connectors suitable for reducing connection.

F. Provide insulated green ground conductor for each branch and feeder circuit.

G. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

H. All connections and terminations installed according to manufacturer's recommendations.

I. All bolted or screw-type terminations specifically torqued to setting specified by manufacturer.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.

    b. Test bolted connections for high resistance using the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey after electrical system activation and is under load.

    c. Inspect compression applied connectors for correct cable match and indentation.

    d. Inspect for correct identification.

    e. Inspect cable jacket and condition.

    f. Insulation-resistance test on each conductor with respect to ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.

    g. Continuity test on each conductor and cable.

    h. Uniform resistance of parallel conductors.

3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice and termination in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

    b. Record of Infrared Scanning: Prepare a certified report that identifies splices and terminations checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice and termination 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Grounding and bonding systems and equipment.

1. Section includes grounding and bonding systems and equipment

1.3 QUALITY ASSURANCE

A. 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.
B. Comply with UL 467 for grounding and bonding materials and equipment.

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. 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.
B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: No. 6, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 inch thick by 2 inches wide by 8 inches long (6.3 by 50 mm by 200 mm), with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. fiberglass reinforced polyester, impulse tested at 5000 V.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless, non-reversible compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Non-reversible compression or exothermic-type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Non-reversible compression or exothermic-type, copper or copper alloy.

J. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

K. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, sectional type; 10 feet by 3/4 inch (3 m by 19 mm) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors for all sizes unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum unless indicated otherwise on drawings.

1. Bury at least 24 inches below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of **five** times the applied force.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with Division 3 section ”Precast Concrete Lighting Pole Bases”.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. U-Channel Strut Systems: Provide 16 gauge steel U-channel strut system for supporting electrical equipment of types and sizes indicated with 9/16-inch diameter holes at 8 inches on center on top surface, with standard galvanized or PVC finish and following fittings that mate and match with U-channel:

a. Fixture hangers.
b. Channel hangers
c. End caps
d. Beam clamps
e. Wiring stud.
f. Thin-wall raceway clamps.
g. Rigid conduit clamps.
h. Raceway hangers.
i. U-bolts.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2.3 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices, complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as specified in this Section. Where more than one type of device meets indicated requirements, select device according to Contractor's option.

1. Fasteners:

a. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
b. Lag Bolts: FS FF-B-561, square head type.
c. Machine Screws: FS FF-S-92, cadmium plated steel.
d. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
e. Wood Screws: FS FF-S-111 flat head carbon steel.
f. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
g. Lock Washers: FS FF-W-84, helical spring type carbon steel.
h. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.
i. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

E. Install hangers, supports, clamps and attachments to support raceway properly from building structure. Arrange for grouping of parallel runs of horizontal raceways to be supported together on trapeze type hangers where possible.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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.

D. Fasteners

1. Materials:

a. Dry Locations: Use cadmium or zinc coated anchors and fasteners.
b. Damp and Wet Locations: Use hot dipped galvanized or stainless steel anchors and fasteners.
c. Corrosive Atmospheres Or Other Extreme Environmental Conditions: Use fasteners made of materials suitable for conditions.

2. Types (unless otherwise specified or indicated):

a. Use cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.

b. Use anchoring devices to fasten items to solid masonry and concrete when anchor is not subjected to pull out loads, or vibration in shear loads.

c. Use toggle bolts to fasten items to hollow masonry and stud partitions.

E. Attachment Devices

1. Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing.

2. Make attachments to steel bar joists at panel points of joists.

3. Do not drill holes in main structural steel members.

4. Use "C" beam clamps for attachment to steel beams

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate

8. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Raceway Support

1. Use pipe straps and specified method of attachment where raceway is installed proximate to surface of masonry construction.

2. Use hangers secured to surface with specified method of attachment where raceway is suspended from the surface.

3. Use "C" beam clamps and hangers where raceway is supported from steel beams.

4. Use channel support system supported from structural steel for multiple parallel raceway runs.

5. Where raceways are installed above ceiling, do not rest raceway directly on runner bars, T-bars, etc.

   a. Raceway Sizes 2-1/2 Inches and Smaller: Support raceway from ceiling supports or from construction above ceiling.
   b. Raceway Sizes Over 2-1/2 Inches: Support raceway from beams, joists, or trusses above ceiling.

G. Light Fixture Support

1. Do not support fixtures from ceilings or ceiling supports unless specified or indicated on Drawings.

   a. Comply with NEC, Article 410.36 – Means of Support.
   b. Support fixtures with hanger rods attached to beams, joists, or trusses–of largest standard diameter-that fits in mounting holes of fixture.
   c. Where approved, channel supports may span and rest upon lower chord of trusses and be used to support lighting fixtures.
   d. Where approved, channel supports may span and be attached to underside of beams, joists, or trusses and be used to support lighting fixtures.

2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).

   a. Where adequately supported outlet box is specified to support fixture or be used as one point of support, support box so that box may be adjusted to bring face of outlet box even with surface of ceiling.

3. Ceiling Mounted Lighting Fixtures: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.

   a. Support individual luminaires less than 2 feet long at 2 points.

   b. Support continuous row of luminaires less than 2 feet wide at points equal to number of fixtures plus one. Uniformly distribute points of support over row of luminaires.

   c. Support individual luminaires 2 feet or wider at 2 corners.

   d. Support continuous row of luminaires 2 feet or wider at points equal to twice number of fixtures plus 2. Uniformly distribute points of support over row of luminaires.

   e. Use adequately supported outlet box as one point of support for fixtures weighing less than 50 pounds.

   f. Support recessed mounted fixtures directly from suspension system of suspended acoustical ceilings and securely fasten fixtures to framing members of ceiling using lock clips, wirelashing or leveling supports. Support each fixture weighing between 10 and 50 pounds (including lamps) independent of suspended ceiling grid with minimum of 2, 12 gauge wires.

4. Wall Mounted Lighting Fixtures: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.

   a. Support individual fluorescent fixtures 2 feet long or less at 2 points.
   b. Support individual fluorescent fixtures over 2 feet long at 3 points.
   c. Support continuous row fluorescent fixtures at points equal to twice number of fixtures. Uniformly distribute points of support.
   d. Adequately supported outlet box may be used as one point of support for fixtures weighing less than 50 pounds

H. Channel Support System: Channel supports may be used, as approved, to accommodate mounting of equipment with following material and finish.

1. Dry Locations: 16-gage steel channel support system with standard finish.
2. Damp and Wet Locations: 16-gage steel channel support system with hot dipped galvanized or PVC finish

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 – Metal Fabrications for site fabricated metal supports.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions for approved equipment but not less 6 inches larger in both directions than the supported unit. Anchors will be a minimum of 10 bolt diameters from the edge of the base.

B. Concrete materials, reinforcement, and placement requirements are specified in Division 3 “Precast Concrete Lighting Pole Bases”.

C. Anchor equipment to concrete base:

1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. EPDM: Ethylene-propylene-diene terpolymer rubber.
D. FMC: Flexible metal conduit.
E. GRC: Galvanized rigid steel conduit
F. LFMC: Liquidtight flexible metal conduit.
G. LFNC: Liquidtight flexible nonmetallic conduit.
H. NBR: Acrylonitrile-butadiene rubber.
I. RNC: Rigid nonmetallic conduit.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT, TUBING AND FITTINGS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.

6. O-Z Gedney; a unit of General Signal.
7. Wheatland Tube Company.

B. Galvanized Rigid Steel Conduit (GRC): Rigid, hot dipped galvanized steel with galvanized threaded malleable iron fittings and bushings with insulated throat (galvanized steel). ANSI C80.1 and UL 6.

C. Electrical Metallic Tubing (EMT): Metallic galvanized steel tube with galvanized steel compression or setscrew type fittings and bushings with insulated throat (galvanized steel). ANSI C80.3 and UL 797.

D. Flexible Metal Conduit (FMC): Flexible, interlocked aluminum metal strip with galvanized screw-in type steel fittings. UL 1.

E. Liquid Tight Flexible Metal Conduit (LFMC) : Liquid-tight flexible metal raceway with single, flexible, continuous, interlocked and double-wrapped steel core galvanized inside and outside, coated with liquid tight jacket of flexible polyvinyl chloride (PVC). UL 360.

F. Fittings:

1. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

2. Fittings for EMT:

a. Material: Steel .
b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

G. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.

11. Thomas & Betts Corporation.
12. RACO; a Hubbell Company.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: NEMA TC 2, UL 651,Type EPC-40-PVC**,** with matching fittings by same manufacturer as the conduit.

D. ENT: Comply with NEMA TC 13 and UL 1653.

E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

F. LFNC: UL 1660.

G. Fittings for LFNC: UL 514B.

H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, UL 870 and NEMA 250, Type 1, 12, 3R, as indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type or as indicated with manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Hubbell, Inc.
    b. Thomas & Betts Corporation.
    c. Walker Systems, Inc.; Wiremold Company (The).
    d. Wiremold Company (The); Electrical Sales Division.

C. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Butler Manufacturing Company; Walker Division.
    b. Enduro Systems, Inc.; Composite Products Division.
    c. Hubbell Incorporated; Wiring Device-Kellems Division.
    d. Lamson & Sessions; Carlon Electrical Products.
    e. Panduit Corp.
    f. Walker Systems, Inc.; Wiremold Company (The).
    g. Wiremold Company (The); Electrical Sales Division.

D. Tele-Power Poles:

1. Material: Aluminum with clear anodized finish.

2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.

11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

C. Outlet Boxes

1. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

2. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy**,** Type FD, with gasketed cover.

3. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

4. Materials

   a. Recessed Applications and Exposed Applications in Unfinished Spaces: Galvanized, stamped steel.

   b. Boxes in stud walls shall be 4" square, 2 1/8" deep boxes with raised covers for power circuits. Provide "Far-Side" box support to keep box alignment parallel with wall face.

   c. Boxes in masonry walls shall be 3 ½" deep masonry boxes, single or multigang as required

   d. Exposed Applications: In finished spaces requiring exposed applications, provide boxes to match surface raceway system. In situations where surface mount conduits are allowed, condulet style boxes shall be used. Where surface mount devices are provided as components of specific systems, provide surface mount box from same manufacturer to match device.

   e. Concrete and Wall in Wet Locations: Heavy duty cast aluminum, thermoset protective silver grey finish, with threaded mounting posts.

   f. Weatherproof Outlet Boxes: Corrosion-resistant cast metal weatherproof outlet wiring boxes of appropriate type, shape, size and depth, with threaded conduit ends and cast metal face plates with cover suitably configured for each application~~,~~ and including face plate gaskets and corrosion resistant fasteners. Do not compromise outlet weatherproof integrity when attachment plug is inserted.

   g. Junction and Pull Boxes: Galvanized code gauge sheet steel boxes with screw-on covers, of appropriate type, shape and size suitable for box location and installation with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

5. Size: As required for number and size of raceways and conductors. Depth to suit wall depth and device installed.

6. Covers: Design and style for each type, outlet, junction box, etc.; NEMA rated for each location.

D. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

E. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering of system contained within.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Raceway Installation: Securely support raceway from building construction, separately from outlet boxes and junction boxes. Secure to masonry surfaces with expansion anchors. Use galvanized hanger rods, inserts and hangers. Conceal all raceway runs except in mechanical rooms, storage room ceilings, and areas above suspended ceilings. Run exposed raceway neatly, parallel and level, to ceilings, walls and floors. Make necessary offsets and bends to comply with construction. Install expansion fittings at all building expansion joints. Support all raceways with clamps per National Electric Code

1. GRC Installation: Use GRC in concrete slabs, below concrete slabs, below grade, damp locations, exterior locations and in hazardous locations. Where exposed leaving concrete slabs, extend minimum 6 inches above and below slabs. Use GRC elbows when penetrating concrete slab from PVC raceway below or in slabs.

2. RNC: Use for underground applications, in slabs, and below slabs. Provide rigid raceway when extending through slabs. Install in accordance with requirements of Article 352 of NEC. Make solvent-cemented joints in accordance with recommendations of manufacturer.

3. EMT: Use EMT for non-hazardous, dry locations above grade. As a minimum, use EMT in corridor ceilings, for home runs and in all unoccupied exposed interior areas. Surface mounted EMT shall not be used in finished areas without written permission from the Architect or Owner.

4. FMC: Use flexible metal conduit for final connections to motors, step-down transformers, vibrating machines, etc. Terminate with clamp type connectors and anti-short bushing. Maximum length of three feet.

5. LFMC: Use a maximum of two feet of liquid tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration and also where subjected to one or more of the following conditions:

    a. Exterior location.
    b. Moist or humid atmosphere where condensate can be expected to accumulate.
    c. Corrosive atmosphere.
    d. Subjected to water spray.
    e. Subjected to dripping oil, grease or water

6. LFNC: Use a maximum of three feet of liquid tight flexible nonmetallic conduit for connection to video cameras and other electrical equipment with extreme bending requirements and also where subjected to one or more of the following conditions:

    a. Exterior location.

7. All non-metallic or flexible conduit shall contain a separate grounding conductor in addition to the circuit conductors.

8. Complete raceway installation before starting conductor installation.

9. Do not secure branch circuit wiring to ceiling support wires. Provide independent support wires dedicated only to electrical raceways.

10. Use roughing-in dimensions of electrically operated units furnished by supplier. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.

11. Provide nylon pull cord in empty raceways. Test empty raceways with ball mandrel. Clear any raceway that rejects ball mandrel. Restore raceway and surrounding surfaces to original condition.

12. Fasten raceway terminations in sheet metal enclosures by 2 locknuts and terminate with bushing. Install locknuts inside and outside of enclosure.

13. Do not cross pipe shafts or ventilating duct openings with raceways.

14. Keep raceways at least 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

B. Concealed Raceways

1. Paint raceway threads in metallic raceways installed underground, in floors below grade, or outside with corrosion-inhibiting compound before assembling couplings. Draw coupling and raceway sufficiently tight to ensure water tightness.

2. For floors-on-grade, install raceways under concrete slabs.

3. Install underground raceways minimum of 18 inches below finished grade.

4. Provide raceway in furniture and any other cavity to effectively create a raceway system from the ceiling space to the outlet.

5. Stub-ups to Above Recessed Ceilings:

   a. Use EMT for raceways.
   b. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

C. Install raceways to avoid damage or penetration of structural members. Avoid horizontal or cross runs in building partitions or sidewalls.

D. For raceway larger than 2 inches, provide minimum 2 inches between raceways vertically penetrating elevated concrete slabs. Provide fire-stopping and spray-on fireproofing at locations where raceways penetrate surface of floor slab that is part of fire rating required for construction.

E. Change from ENT to GRC before rising above floor. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Exposed Raceways

1. Use exposed raceway on exterior surfaces and interior finished spaces only when raceway type and routing are approved by Architect and Owner's representative.

2. Install exposed raceway in unfinished spaces, crawl spaces, pipe spaces, or in areas with existing exposed raceway. In areas where walls/ceilings are to be painted, exposed raceways shall be painted to match.

3. Install exposed raceways and extensions from concealed raceway systems neatly, parallel with, or at right angles to walls of building.

4. Do not run raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeves for raceway runs through these areas.

5. Install exposed raceway to avoid interfering with ceiling inserts, lights or ventilation ducts or outlets.

6. Support exposed raceways using hangers, clamps or clips. Support raceways on each side of bends and space not more than 6 ft. O.C. for 1-inch raceway and not more than 8 ft. O.C. for 1-1/4-inch raceway.

7. Provide exposed raceways for outlets on waterproof walls and set anchors supporting raceway in waterproof cement.

8. Support multiple raceway runs on trapeze style assemblies. Do not support raceway or cable from pipe, ductwork, or other raceway systems.

9. Apply exposed raceways requirements specified above to raceways installed in space above hung ceilings and in crawl spaces.
10. Do not install raceway directly on floors.

G. Minimum Raceway Size: 1/2-inch.

H. Surface Raceways: Use surface raceways in finished spaces to conceal new cabling that cannot be installed above accessible ceiling or within walls. Use surface raceway only when raceway type and routing are approved by Architect and Owner's representative. Securely support from building construction and secure to masonry surfaces with expansion anchors. Mount at heights at locations shown on Drawings; obtain approval from Architect and Owner's representative for all routing not indicated on Drawings. Do not run surface raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeve with junction boxes or adapter fittings for raceway runs through these areas. In existing construction, run raceway along top of baseboards, taking care to avoid telephone and other signal wiring around doorframes and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.

I. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways in Architect's presence to demonstrate that raceway is clear of obstructions. Leave pulling-in line in each spare and empty raceway.

J. Raceway Installation in Special Areas

1. Raceways Exposed to Different Temperatures: Where portions of interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from warmer to colder section through raceway installation.

2. Refrigerated Rooms: Install raceway body or junction box in raceway system on warm side of refrigerated room. After cables are installed, seal raceway interior at raceway body or junction box.

3. Heated Areas to Unheated Areas: After cables are installed, seal raceway interior at nearest raceway body, outlet or junction box in heated area adjoining unheated area.

K. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Provide locknuts for securing raceway to metal enclosure with sharp edge for digging into metal and ridged outside circumference for proper fastening.

2. Provide bushings for terminating raceways smaller than 1-1/4 inches with flared bottom and ribbed sides with smooth upper edges to prevent injury to cable insulation.

3. Install insulated type bushings for terminating raceways 1-1/4 inches and larger with flared bottom and ribbed sides and with upper edge with phenolic insulating ring molded into bushing.

4. Provide screw-type grounding terminal for standard or insulated type bushing.

5. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings and plugs specifically designed for their particular application.

L. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

M. Fittings and Accessories Installation

1. Use zinc electroplate or hot dipped galvanized steel fittings and accessories in conjunction with ferrous raceways in dry and damp locations.

2. Use hot dipped galvanized fittings and accessories in conjunction with ferrous raceways in wet locations.

3. Use caps or plugs to seal ends of raceways until cable is installed (to exclude foreign material).

4. Use deflection fittings where raceways cross expansion joints that move in more than one plane.

5. Use 2 locknuts and insulated bushing (plastic bushing on 1/2-inch raceway and 3/4-inch raceway) on end of each raceway entering sheet metal cabinet or box in dry or damp locations. Terminate raceway ends within cabinet/box at same level.

6. Use watertight hub on end of each raceway entering cabinets or boxes (in wet locations) not constructed with integral threaded hubs.

7. Specific Applications:

   a. Galvanized Rigid Conduit: Use threaded fittings and accessories. Use 3-piece raceway coupling where raceway cannot be rotated.
   b. Flexible Metal Raceway: Use flexible metal raceway connectors.
   c. Liquid Tight Flexible Metal Raceway: Use “seal-tite” connectors.

8. Rigid Nonmetallic Raceway, Metal Surface Raceway, and Wireways: Use manufacturer's standard fittings and accessories.

3.2 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter or as detailed on drawings.

2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

E. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 EXISTING RACEWAYS

A. Conditions for Re-Use of Existing Raceways:

1. Existing raceway is adequately sized for new cables.
2. Remove existing cables.
3. Demonstrate to Architect that existing raceway is clear of obstructions and in good condition.
4. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

3.5 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.

B. Raceways for Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 “Penetration Firestopping”.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of raceway. Include type and number required for raceway material and size of raceway.

3. Pressure Plates: Carbon steel

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of 40 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
C. Secure nailing flanges to concrete forms.
D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE INSTALLATION FOR FIRE RATED ASSEMBLY PARTITIONS

A. Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

B. Maintain indicated fire rating of walls, partitions, ceilings and floors at raceway penetrations. Install sleeves and sleeve seals with appropriate firestop materials. Comply with Division 07 Section “Penetration Firestopping”.

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

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

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

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

G. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

H. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

F. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

4. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

5. Overall Thickness: 5 mils.

6. Foil Core Thickness: 0.35 mil.

7. Weight: 28 lb/1000 sq. ft..

8. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch .

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify raceways and the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Exit lights
2. Power.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels:

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own, user readable identification.

1. Labeling Instructions:

   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, Stenciled legend 4 inches high.

   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.

   b. Enclosures and electrical cabinets.

   c. Access doors and panels for concealed electrical items.

   d. Enclosed switches.

   e. Enclosed circuit breakers.

   f. Enclosed controllers.

   g. Variable-speed controllers.

   h. Push-button stations.

i. Power transfer equipment.

j. Contactors.

k. Remote-controlled switches, dimmer modules, and control devices.

l. Monitoring and control equipment.

END OF SECTION 26 05 53

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.

1. See especially Section 01 08 00, “General Commissioning Requirements” for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.2 SUMMARY

A. Section includes commissioning process requirements for Lighting Control Systems, which are described in more detail in the technical specification 26 09 23 Lighting Control Devices.

1.3 DEFINITIONS

A. CxA: Commissioning Authority.

1.4 SUBMITTALS

A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 01 33 00 "Submittal Procedures" and the individual sections specifying the work.
B. Prefunctional Checklists of readiness.
C. Prefunctional Checklists of completion of installation, prestart, and startup activities.
D. Certificates of readiness and completion of installation.
E. Test and inspection reports and certificates.
F. Corrective action documents.
G. Functional Performance Test Procedures

1.5 QUALITY ASSURANCE

A. Lighting Control Testing Technician Qualifications: Technicians to perform Lighting Control Construction Prefunctional Checklist verification tests and demonstrations, functional performance tests and demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level in Electrical Testing or Installation. Vocational School four-year program graduate or an Associate’s degree in electrical systems, or similar field. Degree may be offset by three years' experience in servicing electrical systems in the HVAC or Electrical industry.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Provide Electrical work in accordance with contract document requirements for Lighting Control Systems.

B. Perform commissioning tests at the direction of the CxA.

C. Attend construction phase coordination meetings.

D. Attend testing, adjusting, and balancing review and coordination meeting.

E. Participate in Lighting Control systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

F. Provide information requested by the CxA for final commissioning documentation.

G. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S AUTHORITY

A. Provide Project-specific construction checklists and commissioning process test procedures for actual Lighting Control systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Directing commissioning.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Lighting Control system to be verified and tested.
4. Prefunctional Checklists certifying that installation, prestart checks, and startup procedures have been completed.
5. Prefunctional Checklists certifying that Lighting Control systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing and adjusting reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that Lighting Control systems have been installed, calibrated, and started and are operating according to the Contract Documents.
B. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. The CxA in cooperation with the Electrical Contractor shall prepare detailed testing plans, procedures, and checklists for Lighting control systems.

3.3 LIGHTING CONTROL SYSTEMS FUNCTIONAL TESTING PROCEDURES

A. Lighting Control System Functional Testing and Acceptance Procedures:

1. Occupancy Sensor Controls:

a. Certify that the occupant sensor has been located and aimed in accordance with manufacturer recommendations.

b. Each occupancy sensor shall be tested, where applicable.

1) Verify the correct operation of occupant sensor controls status indicators.
2) Verify the controlled lights turn off or down to the permitted level within the required time.
3) Verify the lights turn on to the permitted level when an occupant enters the space for auto-on occupant sensor controls.
4) Verify the lights turn on only when manually activated for manual-on occupancy sensors.
5) Verify the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

2. Temerature Control System Time-switch Controls

a. Verify that the time-switch control is programmed with accurate weekday, weekend and holiday schedules.

b. Provide documentation to the owner of time-switch controls programming including weekday, weekend, holiday schedules, and set-up and preference program settings.

c. Verify the correct time and date in the time-switch.

d. Verify that the override time limit is set to not more than 2 hours.

e. For Exterior Lighting Control:

1) Verify and document the following:

a) All lights can be turned on and off by their respective area control switch.
b) Manual Override switches only turn on and off lights in their respective control area.

3. Daylight Responsive Controls

a. Verify control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
b. Verify daylight controlled lighting loads adjust to light level set points in response to available daylight.
c. Verify the locations of calibration adjustment equipment are readily accessible to authorized personal.

B. Provide documentation and certification to the CxA.

C. Lighting Control systems are shown on the contract drawings.

END OF SECTION 26 08 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Outdoor photoelectric switches, solid state, flexible mounting.
2. Outdoor photoelectric switches, solid state, luminaire-mounted.
3. Daylight-harvesting dimming controls, digital.
4. Indoor occupancy and vacancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Conductors and cables.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Outdoor photoelectric switches, low voltage.
2. Daylight-harvesting dimming controls, digital.
3. Indoor occupancy and vacancy sensors.
4. Outdoor motion sensors.
5. Conductors and cables.

B. Shop Drawings:

1. Show installation details for the following:

   a. Occupancy sensors.
   b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.

3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control devices.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Signify.
2. Steinel.

B. Description: Solid state; one set of NO dry contacts rated for 24 V(ac) at 1 A, to operate connected load, complying with UL 773, and compatible with luminaire power pack and lighting control panelboard.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.

3. Time Delay: Thirty-second minimum, to prevent false operation.

4. Mounting: 1/2 inch threaded male conduit.

5. Failure Mode: Luminaire stays ON.

6. Power Pack:

a. Dry contacts rated for 30 LED load at 120 and 277 V(ac..

1) LED status lights to indicate load status.
2) Plenum rated.

b. Digital controller capable of accepting three 8PSJ inputs with **two** outputs rated for 20 Aor LED load at 120 and 277 V(ac. Sensor has 24 V(dc), Class 2 power source.

1) With integral current monitoring.
2) Compatible with digital addressable lighting interface.
3) Plenum rated.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. hubbell.
2. Leviton.
3. Steinel.

B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

1. Lighting control set point is based on the following two lighting conditions:

   a. When no daylight is present (target level).
   b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **integrated** power packto detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

E. Power Pack: Digital controller capable of accepting **three** 8PSJ inputs with **two** output(s) rated for 20 ALED load at 120 and 277 V(ac), for). Sensor has 24 V(dc) Class 2 power source.

1. With integral current monitoring.
2. Compatible with digital addressable lighting interface.
3. Plenum rated.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Hubbell.
2. Leviton.
3. Steinel.

B. General Requirements for Sensors:

1. Ceilingmounted, solid-state indoor occupancyandvacancysensors.

2. Dual technology.

3. Integrated power pack.

4. Hardwiredconnection to switch.

5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

6. Operation:

   a. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Sensor is powered from the power pack

8. Power: Line voltage

9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), Sensor has 24 V(dc), 150 mA, Class 2 power source.

10. Mounting:

    a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
    b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

12. Bypass Switch: Override the "on" function in case of sensor failure.

13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.

4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.

5. Color: As selected by Architect.

2.4 OUTDOOR MOTION SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hubbell.
2. Signify.

B. Description: Solid-state outdoor motion sensors.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application

2. Dual-technology (PIR and ultrasonic) type, weatherproof. Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch. Comply with UL 773A.

3. Switch Rating:

a. Luminaire-Mounted Sensor: LED
b. Separately Mounted Sensor: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), Sensor has 24 V(dc), 150 mA, Class 2 power source.

4. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off." With bypass switch to override the "on" function in case of sensor failure.

5. Voltage: Dual voltage, 120 and 277 V type.

6. Detector Coverage:

   a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
   b. Long Range: 180-degree field of view and 110 ft. detection range.

7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

9. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.

11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as "raintight" in accordance with UL 773A.

2.5 LIGHTING CONTACTORS

A. Description: Electrically operated and electrically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as indicated on Drawings and scheduled, matching the NEMA type specified for the enclosure.

B. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

1. Monitoring: On-off status
2. Control: On-off operation

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.3 INSTALLATION OF CONTACTORS

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.
E. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranded building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed and non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A.

C. Key-Operated Switches, 120/277 V, 20 A:

1. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

C. Cover Plates:

1. Stainless Steel Cover Plates: Type 302 or 304, satin finish, 0.040 inch thick, accurately die cut, protected with release paper. Flush mounting plates shall be beveled with smooth rolled outer edge. Surface mounting plates shall be beveled and pressure formed for smooth edge to fit box. Single and combination plates as required to match types and sizes of specified wiring devices.

2. Weatherproof Cover Plates: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked “Suitable For Wet Locations While in Use” and “UL Listed”. There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and the mounting plate/base to assure proper seal. The installation shall be in compliance with NEC Article 410-57(b). Specification Grade die cast aluminum (copper free alloy 360)as manufactured by Hubbell Corp. (or approved equal).

D. Material for unfinished spaces: Galvanized steel.

2.7 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

B. Provide GFCI outlets for all outlets identified as GFCI. The use of the feed through feature of GFCI outlets is not allowed.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 5 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cylinder.
2. Downlight.
3. Surface mount, nonlinear.
4. Materials.
5. Luminaire support.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.

4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project ES LM-79and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. 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.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. California Title 24 compliant.

2.2 CYLINDER

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Insight Lighting.
2. Meteor Lighting.
3. Signify.

B. Nominal Operating Voltage: As Shown on Drawings.

C. Lamp:

1. Minimum lm; as shown on Drawings.

2. Minimum allowable efficacy of 95 lm/W.

3. CRI of >80. CCT as shown on Drawings.

4. Rated lamp life 50,000hours to L70.

5. Dimmable from 100 percent to zero percent of maximum light output.

6. Internal driver.

7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Color by Owner Representative.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. With integral mounting provisions.

H. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.3 DOWNLIGHT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting Solutions; Signify North America Corp.
2. Lithonia Lighting; Acuity Brands Lighting, Inc.
3. Philips; Signify North America; Signify Holding.

B. Nominal Operating Voltage: 120 V -277 V ac.

C. Lamp:

1. Minimum lumens - refer to luminaire schedule.

2. Minimum allowable efficacy of 90.

3. CRI of 80 CCT of 3500k.

4. Rated lamp life of 50,000 hours to L70.

5. Dimmable from 0-10 percent to zero percent of maximum light output.

6. Internal driver.

7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminumhousing and heat sink.
2. powder-coatfinish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Fixed lens.
2. Batwing light distribution.
3. UV-stabilized acrylic
4. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
5. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.

2. RoHS compliant.

3. UL Listing: Listed for damp location.

4. Recessed luminaires shall comply with NEMA LE 4.

5. Internal driver.

6. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61

7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

H. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.
3. With integral mounting provisions.

I. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

J. Diffusers and Globes:

1. Tempered Fresnel glass.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

K. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.4 SURFACE MOUNT, NONLINEAR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting Solutions; Signify North America Corp.
2. Lithonia Lighting; Acuity Brands Lighting, Inc.
3. Philips; Signify North America; Signify Holding.

B. Nominal Operating Voltage: 120 V – 277 V ac.

C. Lamp:

1. Minimum 4500 lm.

2. Minimum allowable efficacy of 90 lm/W.

3. CRI of 80 CCT 3500K.

4. Rated lamp life of 50,000hours to L70.

5. Dimmable from 0-10 percent to zero percent of maximum light output.

6. Internal driver.

7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying withANSI C81.61

8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. UV-stabilized acrylic
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.5 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 EXAMINATION

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 roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of two locations, spaced near corners of luminaire.

G. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

C. Remove and replace with new, all broken glassware, plastic or fixtures damaged before final acceptance at no additional expense to Owner.

D. No allowance made for breakage or theft before final acceptance.

E. Immediately prior to occupancy, damp clean all diffusers, glassware, fixture trims, reflectors, lamps, and replace burned- out lamps.

3.7 STARTUP SERVICE

A. Verify all luminaires function in conjunction with lighting control system and perform as intended.

1. Illumination is adequate and measured satisfactorily.
2. Dimming performs satisfactorily in accordance with specification.
3. 1 Hour of training of Owner includes technical information about luminaires and is completed in conjunction with lighting control specification.

3.8 UTILITY REBATES

A. Provide Owner with all receipts for the light fixtures, luminaires, etc. eligible for current utility rebate programs at completion of Contract, allowing Owner to apply for rebates and schedule utility company inspections. Provide copy to Architect for record.

END OF SECTION 26 51 19

SECTION 26 56 13 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

1.3 DEFINITIONS

A. EPA: Equivalent projected area.
B. Luminaire: Complete luminaire.
C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
D. Standard: See "Pole."

1.4 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.

B. Shop Drawings:

1. Include mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.

4. Anchor bolt templates keyed to specific poles and certified by manufacturer.

5. Method and procedure of pole installation. Include manufacturer's written installations.

1.5 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Qualification Data: For testing agency.

C. Material Test Reports:

1. For each pole, by a qualified testing agency.

D. Source quality-control reports.

E. Sample Warranty: Manufacturer's standard warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B660.
B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
C. Retain factory-applied pole wrappings on poles until right before pole installation. Handle poles with web fabric straps.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of **pole(s)** that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

B. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

C. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.

D. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

E. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is **mph90 mph**.

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factor: 1.0.

F. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

G. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 ALUMINUM POLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting Solutions; Signify North America Corp.
2. H.E. Williams.
3. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Poles: Seamless, extruded structural tube complying with ASTM B221, Alloy 6061-T6, with access handhole in in pole wall.

1. Shape: Round, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Fasteners: Stainless steelsize and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected by Architect from manufacturer's full range.

2.3 POLE ACCESSORIES

A. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

B. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

C. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept indicated accessories. Include removable flanged access cover secured with bolts or screws.

2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55, with a minimum yield strength of 55,000 psi.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
2. Refer to drawing details.
3. Threading: Uniform National CoarseClass 2A.

B. Nuts: ASTM A563, Grade A, Heavy-Hex.

C. Washers: ASTM F436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
2. Manufacturer Recommendation for washer(s) provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE INSTALLATION

A. Alignment: Align poles as indicated.

B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033053 "Micellaneous Cast-in-Place Concrete."

C. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.4 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect poles for nicks, mars, dents, scratches, and other damage.
B. System function tests.

END OF SECTION 26 56 13

SECTION 26 56 19 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Luminaire types.
2. Materials.
3. Finishes.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color rendering index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaire.

4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

5. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.8 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. 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.

B. UL Compliance: Comply with UL 1598 and listed for wet location.

C. Lamp base complying with ANSI C81.61.

D. Bulb shape complying with ANSI C79.1.

E. CRI and CCT: As shown on Drawings

F. L70 lamp life of 50,000.

G. Lamps dimmable from 0-10 percent of maximum light output.

H. Internal driver.

I. Nominal Operating Voltage: As shown on Drawings

J. In-line Fusing: Separate in-line fuse for each luminaire.

K. Lamp Rating: Lamp marked for outdoor use.

L. Source Limitations:

1. Obtain luminaires from single source from a single manufacturer.

2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE TYPES

A. Area and Site:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Luminaire Shape: Refer to drawings.

3. Mounting: Pole.

4. Luminaire-Mounting Height: Refer to drawings

5. Distribution: Refer to drawings.

6. Diffusers and Globes: Clear polycarbonate.

7. Housings:

   a. Extruded-aluminum housing and heat sink.
   b. powder-coat finish.

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

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 roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls
2. Attached to a minimum 1/8 inch backing plate attached to wall structural members
3. Attached using through bolts and backing plates on either side of wall

G. Wiring Method: Install conductors in raceways. Conceal raceways.

H. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

B. Illumination Tests:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 19

SECTION 26 58 00 – BASEBALL/SOFTBALL SCOREBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SECTION INCLUDES

A. Single-sided LED baseball scoreboard.

1.3 REFERENCES

A. Standard for Electric Signs, UL 48
B. Standard for CSA C22.2 #207
C. Federal Communications Commission Regulation Part 15
D. National Electric Code

1.4 SUBMITTALS

A. Product data: Submit manufacturer’s product illustrations, data and literature that fully describe the scoreboards and accessories proposed for installation.
B. Shop drawings: Submit mechanical and electrical drawings.
C. Maintenance data: Submit manufacturer’s installation, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE AND HANDLING

A. Product delivered on site.
B. Scoreboard and equipment to be housed in a clean, dry environment.

1.6 PROJECT CONDITIONS

A. Environmental limitations: Do not install scoreboard equipment until mounting structure is secure and concrete has ample time to cure.
B. Field measurements: Verify position and elevation of structure and its layout for scoreboard equipment. Verify dimensions by field measurements.
C. Verify mounting structure is capable of supporting the scoreboard's weight and windload in addition to the auxiliary equipment.
D. Installation may proceed within acceptable weather conditions.

1.7 QUALITY ASSURANCE

A. For outdoor use.
B. Source Limitations: Obtain each type of scoring or related equipment through one source from a single manufacturer.
C. ETL listed to UL 48.
D. NEC compliant.
E. FCC compliant.
F. ETLC listed to CSA 22.2 #207.

1.8 WARRANTY

A. Provide 5 years of no cost parts exchange including standard shipping on electronics parts and radios due to manufacturing defects.
B. Provide toll-free service coordination.
C. Provide technical phone support during Daktronics business hours.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Daktronics, Inc., 201 Daktronics Drive, P.O. Box 5128, Brookings, SD 57006-5128.

B. Subject to compliance with requirements and properties of the product listed, products from other manufacturers will be considered if submitted prior to bid in accordance with the stipulations in the Instructions to Bidders.

2.2 PRODUCT

A. Daktronics BA-2518 single-sided baseball scoreboard displays HOME and GUEST scores to 99, INNING to nine and indicates BALL, STRIKE and OUT.

2.3 SCOREBOARD

A. General information

1. Dimensions: 4'-0" high, 9'-0" wide, 0'-8" deep.
2. Weight: 96 lb.
3. Power requirement: 300 W.
4. Color: provide over 150 colors to choose from.

B. Construction

1. Alcoa aluminum alloy 5052 for excellent corrosion resistance
2. Scoreboard back, face, and perimeter: 0.063" thick

C. Digits & Indicators

1. LED color: Red.
2. HOME, GUEST and INNING digits: 18" high.
3. BALL, STRIKE and OUT indicators: 2" diameter.
4. Seven bar segments per digit.
5. PanaView® LED digit technology.
6. All digits and indicators are sealed front and back with weather-tight silicone gel.

D. Captions

1. Vinyl applied directly to scoreboard face.
2. HOME, GUEST, and INNING captions: 8" high.
3. BALL, STRIKE and OUT captions: 6" high.
4. Color: standard white or others available upon request.

E. Additional Equipment

1. Vinyl striping applied around the scoreboard face
2. Custom team name caption in place of HOME

2.4 SCORING CONSOLE

A. Console is an RC-100 wireless handheld controller

B. Scores multiple sports using changeable keyboard inserts

C. Operating range of 10-500'.

D. Console includes:

1. 900 MHz spread spectrum radio with 15 non-interfering channels
2. Rechargeable battery provides 8-10 hours of operation on full charge
3. Durable ABS plastic enclosure to house electronics
4. Sealed membrane water-resistant keyboard
5. 97x32 LCD to verify entries and recall information currently displayed
6. Carrying/operation case with belt clip, wrist and neck strap

E. Additional Equipment

1. Multi-charging unit (charges up to six RC-100 controllers)

2.5 SPONSOR/IDENTIFICATION PANEL

A. Non-backlit logo/sponsor panels: 2’-6” high, 9’-0” wide

1. Construction

a. Signage cabinetry and metal parts shall be made of durable, lightweight aluminum.

b. All sheet metal parts shall be constructed of 0.050"aluminum with an alloy content of 5052-H34 minimum.
c. All painted surfaces shall be primed and painted using automotive industrial finish or better.

2. Sign decoration

a. Sign decoration shall be constructed using self-adhesive vinyl materials with a minimum of a 3-year outdoor warranty.
b. Digitally produced graphics shall be 3M Scotchprint® or equivalent

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting structure is ready to receive scoreboard. Verify that placement of conduit and junction boxes are as specified and indicated in plans and shop drawings. Verify concrete has cured adequately according to specifications.

3.2 INSTALLATION

A. All power and control cables to scoreboards and displays will be routed in conduit. Power to the scoreboards/displays as well as raceways shown on electrical plans by the Electrical Contractor. Scoreboard control wiring including conduit will be the responsibility of the contractor assigned the scoreboard equipment.

B. Install scoreboards and exterior displays to beams in location detailed and in accordance with manufacturer's instructions. Verify unit is plumb and level.

3.3 INSTALLATION – CONTROL CENTER

A. Provide boxes, cover plates and jacks in locations per plans.

B. Test connect control unit to all jacks and check for proper operation of control unit, scoreboard and all features. Leave control unit in carrying case and other loose accessories with Owner's designated representative.

C. Verify earth ground does not exceed 15 ohms.

END OF SECTION 26 58 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Telecommunications outlet/connectors.
3. Cabling system identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. EMI: Electromagnetic interference.
C. IDC: Insulation displacement connector.
D. LAN: Local area network.
E. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
F. RCDD: Registered Communications Distribution Designer.
G. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. ADC.
2. Belden Inc.
3. Berk-Tek; a Nexans company.
4. CommScope, Inc.
5. Draka Cableteq USA.
6. Genesis Cable Products; Honeywell International, Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M Communication Markets Division.
11. Tyco Electronics Corporation; AMP Products.

C. Description: Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568-C.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a blue thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMPcommunications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Dynacom Inc.
5. Hubbell Premise Wiring.
6. Leviton Commercial Networks Division.
7. Molex Premise Networks; a division of Molex, Inc.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics Corporation; AMP Products.

C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.3 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Two -port-connector assemblies mounted in a two gang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.4 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
B. Comply with J-STD-607-A.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Install cables in pathways except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in in all spaces.

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

B. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. UTP Performance Tests:

a. Test for each outlet. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

2. Final Verification Tests: Perform verification tests for UTPsystems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

END OF SECTION 27 15 00

SECTION 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 50/125-micrometer, multimode optical fiber cabling.
3. Coaxial cabling.
4. RS-232 cabling.
5. RS-485 cabling.
6. Low-voltage control cabling.
7. Control-circuit conductors.
8. Fire alarm wire and cable.
9. Identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. EMI: Electromagnetic interference.
C. IDC: Insulation displacement connector.
D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
F. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Allowable pulling tension of cable.
2. Cable connectors and terminations recommended by the manufacturer.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set.

2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

C. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. AMP Netconnect; a brand of Tyco Electronics Corporation.
3. Belden CDT Networking Division/NORDX.
4. Belden Inc.
5. Berk-Tek; a Nexans company.
6. CommScope, Inc.
7. Draka Cableteq USA.
8. Genesis Cable Products; Honeywell International, Inc.
9. Mohawk; a division of Belden.
10. Superior Essex Inc.
11. SYSTIMAX Solutions; a CommScope, Inc. brand.
12. 3M; Communication Markets Division.

B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.

2. Comply with TIA/EIA-568-B.1 for performance specifications.

3. Comply with TIA/EIA-568-B.2, Category 6.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:Type requirements in subparagraphs below are minimum requirements and may be revised to suit Project. Retain options if "permitted substitutions," as defined in NFPA 70, are appropriate for this Project.

    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. AMP Netconnect; a brand of Tyco Electronics Corporation.
4. Belden CDT Networking Division/NORDX.
5. Dynacom Corporation.
6. Hubbell Incorporated; Hubbell Premise Wiring.
7. Leviton Voice & Data Division.
8. Molex Premise Networks; a division of Molex, Inc.
9. PANDUIT CORP.
10. Siemon.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.4 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. General Cable Technologies Corporation.
5. Mohawk; a division of Belden CDT.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.

2. Comply with TIA/EIA-568-B.3 for performance specifications.

3. Comply with TIA/EIA-492AAAA-B for detailed specifications.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   b. Tight Buffered fibers color coded in accordance with TIA/EIA-598 " color coding of fiber optical cables"

5. Fiber Optic Strands:62 Micron Multimode Fiber Optic Strands: Ultra rated to 1Gbps, plenum rated fiber optic cable with 62.5/125um core/cladding diameters, 900um buffer.

   a. Fibers: Meet TIA/EIA 455-45A, Microscopic Method for Measuring Fiber Geometry of Optical Waveguides.

      1) Core Diameter:62.5 +/- 3.0 µm.

      2) Core Non-Circularity: Less than or equal to 6 percent

      3) Cladding Diameter: 125 +/-2.0 µm.

      4) Cladding Non-Circularity: Less than 2.0 percent

      5) Core to Cladding Offset: Less than 1.5 µm.

      6) Core-to-Cladding Concentricity: Less than or equal to 3.0 µm

      7) Coating Diameter: 245 +/-5 µm

      8) Refractive Index Profile: Graded index

      9) Numerical Aperture: 0.275 +/-0.015

      10) All optical fibers proof tested at minimum of 100kpsi and stress of 0.70 GN/m2 by manufacturer.

      11) Fiber Coating: Layer of acrylate protective coating in physical contact with cladding surface and removable with commercially available stripping tool in single pass and cleaned with 98 percent isopropyl alcohol.

   b. Typical Attenuation For Optical Fibers: 2.9 dB/Km 850 nm wavelength. (3.5 dB/Km max)

      1) Maximum Attenuation: 3.5 dB/km at 850 nm 1.0 dB/km at 1300 nm. For tight-buffered cables, maximum 1.5 dB/km at 1300 nm.

2) Attenuation Uniformity: No point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.
3) Attenuation at Water Peak: Attenuation coefficient at 1380 nm not exceeding attenuation coefficient at 1300 nm by more than 1.0 dB/km.
4) Macrobend Attenuation: Attenuation due to 100 turns of fiber around 75 +/- 2 mm diameter mandrel not exceeding 0.5 dB at 850 nm or 1300 nm.

c. Minimum LED Transceiver Bandwidth Requirements: 200 MHZ at 1 Km at 850 nm wavelength and 500 MHZ at 1 Km at 1300 nm wavelength.

1) IEEE 802.3z Performance: Supports laser-based Gigabit Ethernet (GbE) operation in 1000BASE-SX operating window (850 nm) at 400 meters, and in 1000BASE-LX operating window (1300 nm) at 1000 meters, without using mode conditioning (offset) patchcords.

2) Minimum Restricted Mode Launch (RML) Bandwidth: Greater than or equal to 385 MHz km at 850 nm

d. Cable Operating Temperature Range:

1) Inside Cables: -20 degree Celsius to +70 degree Celsius.
2) Outside Cables: -40 degree Celsius to +70 degree Celsius.

e. Cable Storage Temperature Range: -40 degree C Celsius to + 70 degree Celsius.

f. Maximum Tensile Load: 270 lbs. short term.

g. All terminations on multimode fibers made with connectors approved for purpose and type of cable being terminated.

1) For convenience, details and specifications based on “UniCam 95-000-XX” by Corning/Siecor or AMP Light Crimp Plus with ceramic ferrule.
2) Provide SC type connectors to match patch panels or as specified on Drawings.
3) Provide additional components such as fan-out kits, buffer tubes, and similar components where required for proper termination of cable.

6. 50 Micron Multimode Fiber Optic Strands: Rated to 10Gbps, plenum rated fiber optic cable with 50/125um core/cladding diameters 900um buffer.

a. Standards:

1) UL listed for plenum use; meeting NEC, Article 770 - Optical Fiber Cables and Raceways and passed UL 910 flame test.
2) Tight buffered fibers color coded in accordance with TIA/EIA-598 “Color Coding of Fiber Optic Cables“.
3) Differential Mode Delay per TIA-492.

b. Fibers: Meet TIA/EIA 455-45A, Microscopic Method for Measuring Fiber Geometry of Optical Waveguides.

1) Core Diameter:50.05 +/-2.5 µm.

2) Core Non-Circularity: Less than or equal to 6 percent

3) Cladding Diameter: 125 +/-2.0 µm.

4) Cladding Non-Circularity: Less than 2.0 percent

5) Core to Cladding Offset: Less than 1.5 µm.

6) Core-to-Cladding Concentricity: Less than or equal to 3.0 µm

7) Coating Diameter: 245 +/-5 µm

8) Refractive Index Profile: Graded index

9) Numerical Aperture: 0.200 +/- 0.015

10) All optical fibers proof tested at minimum of 100kpsi and stress of 0.70 GN/m2 by manufacturer.

11) Fiber Coating: Layer of acrylate protective coating in physical contact with cladding surface and removable with commercially available stripping tool in single pass and cleaned with 98 percent isopropyl alcohol.

12) Specifications based on "InfiniCor SX+" by Corning; "GIGAlite-10 XB" by Berktek; and "LaserCore 300 5L" by Commscope.

c. Typical Attenuation For Optical Fibers: 2.9 dB/Km 850 nm wavelength. (3.5 dB/Km max)

1) Maximum Attenuation: 3.5 dB/km at 850 nm 1.0 dB/km at 1300 nm. For tight-buffered cables, 1.5 dB/km at 1300 nm.
2) Attenuation Uniformity: No point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.
3) Attenuation at Water Peak: Attenuation coefficient at 1380 nm not exceeding attenuation coefficient at 1300 nm by more than 1.0 dB/km.
4) Macrobend Attenuation: Attenuation due to 100 turns of fiber around 75 +/- 2 mm diameter mandrel not exceeding 0.5 dB at 850 nm or 1300 nm.
5) Differential Mode Delay: 0.88 ps/m

d. Minimum LED Transceiver Bandwidth Requirements: 1500 MHZ at 1 Km at 850 nm wavelength and 500 MHZ at 1 Km at 1300 nm wavelength.

1) IEEE 802.3z Performance: Supports vertical cavity surface emitting (VCSEL) laser-based 10 Gigabit Ethernet (10GbE) operation in 1000BASE-SX operating window (850 nm) at 550 meters.

e. Cable Operating Temperature Range:

1) Inside Cables: -20 degree Celsius to +70 degree Celsius.
2) Outside Cables: -40 degree Celsius to +70 degree Celsius.

f. Cable Storage Temperature Range: -40 degree Celsius to + 70 degree Celsius.

g. Maximum Tensile Load: 270 lbs. short term.

h. All terminations on multimode fibers made with connectors approved for purpose and type of cable being terminated.

1) For convenience, details and specifications based on "UniCam 95-000-XX" by Corning/Siecor with ceramic ferrule.
2) Provide SC type connectors to match patch panels or as specified on Drawings.
3) Provide additional components such as fan-out kits, buffer tubes, and similar components where required for proper termination of cable.

7. Single-Mode Fiber Optic Strands: H rated, plenum rated fiber optic cable with 8.3/125um core/cladding diameters, 900um buffer.

a. Standards

1) UL listed for plenum use; meeting NEC, Article 770 - Optical Fiber Cables and Raceways and passed UL 910 flame test.

2) Tight buffered fibers color coded in accordance with TIA/EIA-598 "Color Coding of Fiber Optic Cables".

3) Single-mode fiber utilized in optical fiber cable meeting TIA/EIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers," and ITU recommendation G.652, "Characteristics of Single-Mode Optical Fiber Cable"

b. Fibers: Meet TIA/EIA 455-45A, Microscopic Method for Measuring Fiber Geometry of Optical Waveguides.

1) Core Diameter:8.3 nominal

2) Cladding Diameter: 125 +/- 2.0 µm

3) Core to Cladding Offset: Less than or equal to 1.5 µm

4) Core-to-Cladding Concentricity: Less than or equal to 0.8 µm

5) Cladding Non-Circularity: Less than or equal to 1.0 percent

6) Coating Diameter: 245 +/-10 µm

7) Colored Fiber Nominal Diameter: 256 µm

8) All optical fibers proof tested at minimum of 100kpsi and stress of 0.70 GN/m2 by manufacturer.

9) Fiber Coating: Layer of acrylate protective coating in physical contact with cladding surface and removable with commercially available stripping tool in single pass and cleaned with 98 percent isopropyl alcohol.

c. Maximum Attenuation: 0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm. For tight-buffered cables, 1.0 dB/km at 1310 nm and 1.0 dB/km at 1550 nm.

d. Attenuation Uniformity: No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.

e. Attenuation at Water Peak: Attenuation at 1383 ± 3 nm not exceeding 2.1 dB/km.

f. Cutoff Wavelength: Cabled fiber cutoff wavelength (lambda cff) less than or equal to 1260 nm.

g. IEEE 802.3z Performance: Supports laser-based Gigabit Ethernet (GbE) operation in 1000BASE-LX (1300 nm) operating window at 5000 m.

h. Macrobend Attenuation: Attenuation due to 100 turns of fiber around 75 +/-2 mm diameter mandrel not exceeding 0.05 dB at 1310 nm and 0.10 dB at 1550 nm

i. Zero Dispersion Wavelength (λo): 1302 nm less than or equal to λo less than or equal to 1322 nm.

j. Zero Dispersion Slope (S_O): Less than or equal to 0.092 ps/($nm^2 \cdot km$)

k. Maximum Dispersion: Less than or equal to 3.55 ps/(nm·km) from 1285 nm through 1330 nm and greater than 18 ps/(nm·km) at 1550 nm.

l. Fiber Curl: Greater than or equal to 2.0 m radius of curvature.

m. Individual Fiber Polarization Mode Dispersion (PMD): Less than or equal to 0.5

n. Cable Operating Temperature Range:

o. Inside Cables: -20 degree Celsius to +70 degree Celsius.

p. Outside Cables: -40 degree Celsius to +70 degree Celsius.

q. Cable Storage Temperature Range: -40 degree Celsius to +70 degree Celsius

r. Maximum Tensile Load: 270 lbs. short term

s. All terminations on single-mode optical fibers factory-made using machine-polished process and exhibiting minus 45 db or better back-reflection after being fusion-spliced to cable strands in field; similar to factory-manufactured pre-terminated single-mode pigtail assemblies by Corning/Siecor. Provide additional components such as fan-out kits, buffer tubes, and similar components where required for proper termination of cable. Connectors shall be SC type.

8. Backbone Cabling: Consists of tight buffered or loose tube cable with equal parts of multimode and single-mode fibers to provide for future bandwidth needs. (For example, 24-fiber cable contains 12 fibers multimode and 12 fibers single-mode.) Install only in interior spaces where not subject to physical damage.

   a. Backbone Cables Not Installed In Conduit: Plenum rated and TYPE OFNP listed in accordance with National Electrical Code (NEC) and installed in minimum 1-inch plenum rated inner duct.

   b. Complete Hybrid Backbone Plenum Rated Distribution Style Cable: 12 single-mode matched-clad optical fibers and 12 multimode U (ultra) rated optical fibers enclosed in plenum rated orange jacket; similar to "(xxxx88-331xx-29) OFNP MIC 88 series Gigabit Plus CL" by Corning Cable Systems; "P-024-DS-CM-FSDOR8A012/6U012" by Commscope, or "PDP6B024 Gigalite" by Berk-Tek or AMP 4-1664085-1.

   c. Plenum Rated Hybrid Backbone Cable with Metal Armor Sheath: Intra-building backbone cable, TYPE OFCP listed for plenum applications, with optional interlocking steel or aluminum armor with PVC jacket in color matching jacket color of optical fiber cable located inside of armor. Armor comparable to liquid tight flexible metal conduit if jacketed or flexible metal conduit if not jacketed.

      1) Twelve single-mode matched-clad optical fibers and twelve multimode U (ultra/gigabit-CL) rated optical fibers enclosed in plenum rated jacket; similar to "OFCP listed, 2-24 fibers xxxK88-33150-A3, 62.5 µm aluminum armored with plenum jacket, xxxR88-33131-A3, single-mode aluminum armored with plenum jacket" by Corning Cable Systems. Other acceptable manufacturers include Berk-Tek and Commscope, Sumitomo Electric Lightwave and/or approved equal.

         a) Cable Armor: Steel or aluminum armor with positive interlock in accordance with UL 444, Section 4.10 and Table 4 applied directly over cable jacket.

         b) Use Locations: Interior spaces where physical protection desired or required without inner duct requiring "fishing" of cable or placed in tightly spaced locations or substitute for non-armored cable in inner duct in interior locations where not subject to environmental conditions unsuitable for metal armor.

9. Fiber-Optic Horizontal Cable for Station Wiring (use only in locations where fiber optic station wiring is required): 2 pair multimode optical fibers in plenum rated orange jacket for use in wiring from closet patch panels to workstation outlets with small bending radius in cable for use in large variety of interior jack locations. Similar to "004K88-31150-29 by Corning Cable Systems, P-004-DS-6U" by Commscope. Acceptable manufacturers include Berk-Tek, Commscope, Sumitomo Electric Lightwave and/or approved equal.

    a. Placed in plenum rated inner duct or other protective sheath where not fully supported in conduit or raceway.
    b. Horizontal cabling tight buffered, plenum (OFNP) rated unless installed in conduit and listed in accordance with the National Electrical Code.

10. Fiber Optical Cables for Outdoor Placement and Building Entry:

    a. Aerial Placement Cables: UV resistant jackets, designed for aerial placement, and supported in accordance with manufacturers requirements. Distribution style cable with integral water blocking construction similar to "ALSZH, Z-024-DS-CM-FSDBK/8A012/6U012" by Commscope and "ALTOS/LSZHJ OFN-LS (024RWZ-14101A20, 24 fiber single-mode" by Corning Cable Systems, "LTP12B024-AB0504" by Berk-Tek.

    b. Underground Cables in Duct/Conduit: Distribution style cable rated for both indoor riser and outdoor use with integral water blocking construction similar to "FREEDM cable (024RWF-14101A20, 24 fiber single-mode)" by Corning Cable Systems and "LSZH, Z-024-DS-CM-FSDBK/8A012/6U012" by Commscope or "LTP12B024" by Berk-Tek.

    c. Underground Cables for Direct Burial: Distribution style cable with integral water blocking construction similar to "W5-141 (024RW5-14101A20, 24 fiber single-mode, armored ALTOS cable" by Corning Cable Systems and "O-024-LA-CM-FSDBK/8A012/6U012" by Commscope or "PDPK6B024-AB0504" by Berk-Tek.

    d. Plenum-Rated Fiber Optical Cables for Outdoor Placement (may be used in underground duct and in building interior spaces): Approved Fiber optical distribution underground cable for duct placement, rated for both indoor plenum and outdoor use; similar to "LTP12B024-012CB3510/55-012AB0504 with GIGAlite Fiber" by Berk-Tek "FREEDM cable 024R8P-33131-29" by Corning Cable Systems, or "P-024-LN-XY-F12BK" by Commscope. Provide inner duct or conduit for interior placement.

    e. Inner Duct For Interior Placement: 1-inch plenum-rated inner duct similar to "#PLM100 (T)" by Pyramid Industries, "PVDF (PC-100-PL)" by Petroflex, or "PEC-100T-XXXX" by Premier Conduit.

    f. Fabric Inner Duct: 4 inch conduit or 2 inch conduit 3 cell fabric inner duct with factory installed pulling tape in each cell; similar to "MaxCell MXC-3456-XX" or "MaxCell MXC 2003" by TWC. Provide fabric inner duct where shown on Drawings and where existing cabling is in existing conduit.

g. Semi-Rigid PE Corrugated Inner Duct For Outdoor Placement In Underground Ducts: 1-1/4 inch or 1 inch orange color with pull rope in size shown on Drawings; similar to “Opti-Guard AW4X1A or AF4X1A” by Carlon, "Corrugated Petroduct (PC-100-PL)" by Petroflex, or "DRA130905" by Dura-Line.

h. Underground Warning Tape: 3-inch wide tape labeled “Caution - Fiber Optic Cable Buried Below” and buried 1 ft. below finish grade for all fiber optic cable runs. Similar to “MAT3056; Multilink FOT31000” by Carlon "D3105O" by Presco, or "PUWT-312" by Stranco

i. Underground Pull Box For Fiber Optical Cabling: Quazite minimum36-inch long x 24-inch wide at depth to match correct burial depth as shown on drawings for conduit or to match existing.

j. Restrictions

1) Do not place un-rated or riser-rated cable in interior ceiling spaces, air plenums, or other areas where plenum rated material is specified or required unless enclosed in metal conduit.

2) Leave lengths of un-rated or riser-rated not exceeding 50 feet exposed per NEC Article 770.

11. Fiber Optic Patch/Jumper Cables: Factory assembled optical fiber assemblies with multimode fiber and SC connectors at each end. Exact lengths determined in field and based on actual rack layouts. Provide exact quantity as required to patch all rack-terminated ports to network electronics ports, plus 10 percent spare. Provide ceramic connector sleeves.

a. Cable Length: 3 meter long, unless otherwise specified. Verify quantity and length at time of installation.

b. Provide all jumpers conforming to TIA 568-B Standard.

c. Manufacturer: Similar to “Corning Cable Systems, (xxxx01R3131003M, single-mode single fiber jumper, 3 meters in length. xxxx01K3141003, multimode 62.5 µm single fiber jumper, 3 meters in length, OR-611-50D-[XX]-[YYYY]-[ZZ]-C“ by Ortronics or AMP 492019-3 (SM SC-SC) and AMP 504971-3 (MM SC to SC).

12. Jacket:

a. Jacket Color: Aqua for 50/125-micrometer cable, Orange for 62.5/125-micrometer cable .
b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

2. Rack Mounted Fiber Optic Connector Housings and Patch Panels

a. Manufacturers - For convenience, details and specifications based on:

1) Connector Housing and Jumper Management Panel: “CCH-04U with CJP-01U ” by Corning Cable Systems or AMP 559552-2
2) 72 Port Panel: “No. OR-625MMC-72PB1B" by Ortronics.
3) 48 Port Panel: “No. OR-625MMC-48PB1B" by Ortronics or AMP 559614-2.
4) 24 Port Panel: “No. OR-625MMC-24PB1RB" by Ortronics or AMP 559542-2.

b. Rack mounted unit, suitable for standard 19-inch equipment rack, providing interconnect between horizontal wiring and patch cable to wiring hub and equipped with smoked plexiglas door with metal trim and lock. Black color (verify color with Architect prior to installation).

c. Housings mountable in EIA-310 compatible 465 or 592 mm rack and available in several sizes, including 1U, 2U, 3U and 4U.

1) One EIA rack space or panel height (denoted as 1U) defined as 44.45 mm in height.

d. Modular unit with separate splicing, connector, and jumper management and combination connector/splicing housings available.

e. High density multiple fiber cabinet housing, with slide out drawers, providing exact quantity of multimode/single-mode connectors required to terminate all fiber-optic strands for each backbone cable at each rack, plus 10 percent spare for future expansion, and including ceramic connector sleeves.

f. Housing includes provisions for mounting fiber fan-out devices required to build 250-µm fiber in buffer tubes out to 900 µm for fiber protection and to allow direct connectorization.

g. Brackets included allowing wall mounting of rack mount hardware with space for jumper management panels.

h. Provide patch panels at each rack location to accommodate total number incoming cables being terminated with 20 percent spare capacity for future expansion.

i. Properly identify single-mode and multimode fiber terminations.

3. Surface-Mounted Fiber Connector Housings

a. Manufacturers - For convenience, details and specifications based on:

1) Pre-Assembled with SC- Connectors: "No. OR-615SC224-00"by Ortronics.
2) "WCH-02P, WCH-04P, WCH-06P, WCH-08P, WCH-12P" by Corning Cable Systems or AMP 1278755-1.

b. Multiple ports designed for wall-mount applications to enclose patching, splicing, or demarcation of single-mode or multimode fibers and provide for direct connectorization or pigtail splicing. Black color (verify color with Architect prior to installation).

c. Provide wall-mountable connector housing in connector panel version to provide for varying fiber counts and meeting functional requirements specified in "Connector Panels" subparagraph below.

d. Standard connector housing configured for direct connectorization with provision for mounting fiber fan-out devices incorporated into housing. Fiber fan-out devices build 250 µm fiber in buffer tubes out to 900 µm for fiber protection and to allow connectorization.

e. Unit mountable on standard plywood walls.

f. Housings manufactured using 16-gauge aluminum or equivalent for structural integrity and finished with wrinkled black powder coat for durability. Assembly hardware and equipment attaching machine screws included in black color.

4. Connector Panels

a. Manufacturers: For convenience, details and specifications based on "CCH-CP06-xx" for six fiber adapter panels or "CCH-CP12-xx" for twelve fiber adapter panels by Corning Cable Systems.

b. Multiple-port designed for patching, splicing, or demarcation of single-mode or multimode fibers.

c. Rack and wall mountable connector housings accept interchangeable connector panel defined as modular removable plate containing optical fiber connector adapters or copper jacks.

d. Utilizes single mounting footprint with multiple connector adapters in each panel. Interchangeable between rack and wall mountable hardware.

e. Provide ceramic connector sleeves

f. Provide industry standard single fiber and small form factor multi-fiber adapters, including LC, SC duplex, ST compatible, FC, and MT-RJ.

g. Provide connector panels with fiber adapters that match the grade of optical fiber glass of the fiber cable.

h. Blank connector panels provided to fill unused space within housings attached with at least two push-pull latches allowing quick installation and removal. Housings supplied with blank connector panels for all available

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

2. Quick-connect, simplex and duplex, Type SC or Type LC connectors. Insertion loss not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

4. Connector Panels

a. Manufacturers: For convenience, details and specifications based on “CCH-CP06-xx” for six fiber adapter panels or “CCH-CP12-xx” for twelve fiber adapter panels by Corning Cable Systems.

b. Multiple-port designed for patching, splicing, or demarcation of single-mode or multimode fibers.

c. Rack and wall mountable connector housings accept interchangeable connector panel defined as modular removable plate containing optical fiber connector adapters or copper jacks.

d. Utilizes single mounting footprint with multiple connector adapters in each panel. Interchangeable between rack and wall mountable hardware.

e. Provide ceramic connector sleeves.

f. Provide industry standard single fiber and small form factor multi-fiber adapters, including LC, SC duplex, ST compatible, FC, and MT-RJ.

g. Provide connector panels with fiber adapters that match the grade of optical fiber glass of the fiber cable.

h. Blank connector panels provided to fill unused space within housings attached with at least two push-pull latches allowing quick installation and removal. Housings supplied with blank connector panels for all available positions unless housing ordered with optical fiber adapters pre-installed.

2.6 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpha Wire Company.
2. Belden CDT Networking Division/NORDX.
3. Coleman Cable, Inc.
4. CommScope, Inc.
5. Draka Cableteq USA.

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for CCTV transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a nominal attenuation of no more than 7dB/100ft. at 1000MHz.

C. RG-6/U: NFPA 70, Type CM or CMP

1. No. 18 AWG, solid barer copper conductor.
2. Gas-injected, foam-PE insulation.
3. Shielded with 95 percent bare copper braid.
4. Jacketed with PVC.
5. Suitable for indoor and outdoor installations.

2.7 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Emerson Network Power Connectivity Solutions; AIM Electronics brand.
2. Leviton Voice & Data Division.
3. Siemon.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.8 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.9 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.10 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.

4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway and power-limited cable, complying with UL 83, concealed in building finishes.
C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.12 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire; a brand of Belden Inc.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, or Twisted, unshielded pair, not less than No. 18 AWG. Refer to manufacturer for recommended sizes and shielding requirements.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.

2. Line-Voltage Circuits: No. 12 AWG, minimum.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.13 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. PANDUIT CORP.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.14 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.

2. Secure conduits to backboard when entering room from overhead.

3. Extend conduits 3 inches above finished floor.

4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.3 WIRING METHOD

A. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Install cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

E. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

G. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

H. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.6 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.7 CONNECTIONS

A. Comply with requirements in Division 28 Section "Perimeter Security Systems" for connecting, terminating, and identifying wires and cables.
B. Comply with requirements in Division 28 Section "Intrusion Detection" for connecting, terminating, and identifying wires and cables.
C. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.
D. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.
E. Comply with requirements in Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" for connecting, terminating, and identifying wires and cables.

3.8 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."
B. Comply with TIA-569-B, "Firestopping" Annex A.
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.9 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. 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.

4. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

5. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System."

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 28 05 13

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above and below-grade site improvements.
6. Disconnecting, capping or sealing, abandoning site utilities piping in place and removing site utilities structures, i.e., drainage catch basins and fueling area structures.
7. Temporary erosion and sedimentation-control measures.
8. Disposal of waste material.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil (insitu): Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain as Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS, GENERAL

A. General: Submit all informational submittals required by this Section concurrently.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.7 CLOSEOUT SUBMITTALS

A. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface site drainage, water service, structural, electrical, and mechanical conditions.

1.8 PROJECT CONDITIONS

A. Verification of Conditions: Examine conditions under which site clearing is to be accomplished and notify Construction Manager and Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with site clearing until unsatisfactory conditions have been corrected.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises in location to be determined by Owner.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction. Refer to Section 31 25 00, “Erosion and Sedimentation Controls”.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 31 25 00 "Erosion and Sedimentation Controls."

B. Should any trees or shrubs be damaged which are to be saved, arrange to have such damage treated by a licensed arborist or tree surgeon.

C. Protect tree and shrub root systems from smothering. Do not store construction materials, debris, or excavated material within plant protection zone. Do not permit vehicular traffic or parking within plant protection zone. Restrict foot traffic to prevent excessive compaction of soil over tree, shrub and turf root systems.

D. Trees or shrubs which die because of the Contractor's failure to conform to the Drawings and specifications shall be evaluated by a qualified organization selected by the Owner's Representative. The removal and replacement of the tree, and the evaluation expenses shall be paid for by the Contractor. Contractor shall be required to replace the damaged tree with plant material of comparable size and quality (i.e., damaged 12" caliper Red Maple shall be replaced by three 4" cal. or four 3" cal. Red Maples). Substitutions for variety shall be approved by the Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager not less than ten working days in advance of proposed utility interruptions.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a minimum depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer in accordance with Section 31 20 00 "Earth Moving".

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Do not remove surplus topsoil from site.

D. Refer to Section 32 92 00 "Turfs and Grasses" for topsoil screening requirements.

E. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

F. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction including foundations, slabs, paving, curbs, gutters, retaining walls, aggregate base and other improvements.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically. Leave cut edge neat and square where existing material is cut to adjoin new work.

2. Remove asphalt concrete paving material to full depth and remove from site. Do not use asphalt materials for on-site fill.

3. Gravel and stone fill under removed sidewalks may be reused if suitable for the particular new use and if approved by the Architect.

4. Break up and completely remove miscellaneous concrete, such as small foundations. Remove concrete, retaining walls or foundations below grade to a minimum depth of 2'.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for walks, pavements and turf and grasses.
2. Structural Fill: For backfill under structures, pavements, concrete pads, etc.
3. Granular Fill: Subbase for asphalt paving, concrete paving, etc.
4. Subsurface drainage fill for infiltration drainage, underdrains, etc.
5. Excavating and backfilling for buildings and structures.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 31 10 00 - Site Clearing
2. Section 31 23 19 – Dewatering
3. Section 32 92 00 - Turf and Grasses
4. Section 32 93 00 – Plants
5. Section 33 41 00 – Storm Utility Drainage Piping

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Subbase: Granular aggregate layer supporting the slab-on-grade and pavement that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Geotechnical Engineer.

2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Geotechnical Engineer or Architect. Unauthorized excavation, as well as remedial work directed by Geotechnical Engineer or Architect shall be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Hazardous Soil Materials: Soils that are contaminated with petroleum product and/or hazardous chemicals, waste, or industrial waste.

J. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Rock Excavation: Track-mounted excavator rated at not less than 222-hp flywheel power with weight of 70,000 lbs or greater and a 30-in wide short-tip radius rock bucket. (Ratings are based on Caterpillar's "Model No. 330B”.)

K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below aggregate base, structural fill, drainage fill, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

N. Non-Granular Fill: Soil fill material used to raise existing grades in areas that do not require granular or structural fill.

O. Well-Graded: Soils containing a good range of all representative particle sizes between the largest and the smallest. All sizes must be represented, and no one size should be either overabundant or missing.

P. Poorly-Graded: Soils which either contain a narrow range of particle sizes or have some intermediate sizes lacking.

1.4 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of the following manufactured products required:

a. Geotextiles.
b. Warning tapes.

2. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

a. Classification according to ASTM D 2487.
b. Laboratory compaction curve according to ASTM D 1557.
c. Submitted material testing and analysis shall demonstrate that no unsuitable soil groups are present.
d. Submitted material testing and analysis shall demonstrate that no absorbent clays are present.

3. Delegated-Design Submittal:

a. For excavations greater than or equal to 20 feet in depth require engineered systems design per OSHA requirements, signed and sealed by a professional engineer, and submitted for review.

b. Plan for protection of persons passing excavations including diagram or description of means and methods to protect all people from project hazards through the duration of the project shall be submitted for review.

4. Samples for Verification: For the following products, in sizes or quantities indicated below:

a. Fill: One-half gallon by volume of material in sturdy container of each type of fill, naming source for each material.
b. Geotextile: 12 by 12 inches.
c. Warning Tape: 12 inches long; of each color.

5. Verification of Conditions: Written confirmation from installer that installation of Earthwork Materials installed in accordance with specifications.

C. Informational Submittals:

1. Qualification Data: For qualified testing agency.

2. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Qualified Installers as defined below:

1. Earthwork Contractor Experience Requirements: Provide a list of at least four Earthwork projects of comparable size, scope, and quality completed successfully by the proposed Sub Contractor within the past two years that includes the date completed, project Owner's name and current contact information, including telephone numbers and e-mail addresses.

2. Natural Turf Athletic Field Installer Experience Requirements: For specifications regarding experience requirements for Natural Turf Athletic Field Installer, refer to Project Manual Section 32 92 00, TURF AND GRASSES.

B. Baseball/Softball Infield Installation Requirements: Infield Mix manufacturer's representative shall be onsite to inspect prepared infield subgrade and observe installation procedures for each new infield.

1. Turf Installer: Engage an experienced turf installation firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance.

2. Natural Turf Athletic Field Installer: Engage an experienced turf installation firm to perform athletic field work of this Section. Firm shall have completed athletic field work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance.

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

C. Civil/Structural Preconstruction Conference: Attend Civil/Structural Preconstruction Conference.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: If work includes improvements on adjoining property, written authorization for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary and permanent erosion- and sedimentation-control measures, specified in Division 31 Section "Erosion and Sedimentation Control" are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Division 31 Sections "Erosion and Sedimentation Control" and "Site Clearing" are in place.

F. The following practices are prohibited within tree- or plant-protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
8. Directing vehicle or equipment exhaust towards protection zones.
9. Heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Existing Hazardous Materials:

1. If during the performance of the work suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. If present, hazardous materials will be removed by Owner under a separate contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Materials:

1. General: Provide imported soil materials when sufficient satisfactory soil materials are not available from onsite excavations.
2. Topsoil: Refer to Turf and Grasses Specification, Division 32.

B. Hazardous Materials:

1. Provide fill materials that are not contaminated with petroleum product, hazardous waste or industrial waste.
2. Contamination above federal, state or local requirements is not acceptable. Materials with a visible sheen or petroleum odor shall be rejected.

C. Unsuitable Soils: (Includes excavated native and imported non-granular, granular and structural fill materials)

1. Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

    a. Soils Materials shall not contain any absorbent aluminum phyllosilicates, including but not limited to: bentonite (sodium, calcium, or potassium), tonstein, montmorillonite, kaolinite. or other absorbent clays.

2. Unsuitable soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

3. Submitted material testing and analysis shall demonstrate that material classification meets ASTM-D2487 USC system criteria and that no unsuitable soil groups, or absorbent clays are present.

D. Non-Granular Fill: Material is to comply with NYSDOT requirements for Select Borrow and Select Fill with modifications shown below. This material is not allowed in areas where granular soils are required, including within the building footprint, below pavement areas or below a synthetic turf athletic field.

1. On-Site Non-Granular Fill

    a. Submittal must be provided demonstrating that on-site soil material meets the criteria outlined in this Section for use as fill material.

    b. Obtain approval of Architect before proceeding with use of on-site material.

    c. Material is to have no particles greater than 3” in maximum dimension, no more than 70% by weight passing the #40 sieve and no more than 20% passing the #200 sieve.

    d. Testing submitted is to demonstrate that proper compaction can be achieved as required in Part 3, Execution.

2. Imported Non-Granular Fill

    a. Where quantity of approved non-granular fill materials required exceeds that available from on-site stockpiles, provide suitable material from off-site sources.

    b. Obtain approval of Architect before proceeding with use of imported fill material.

    c. Material is to have no particles greater than 3” in maximum dimension, no more than 70% passing by weight the #40 sieve and no more than 15% passing the #200 sieve.

    d. Testing submitted is to demonstrate that proper compaction can be achieved as required in Part 3, Execution.

E. Structural Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand.

1. Type 1 Fill (NYSDOT ITEM No. 304.11 Granular Fill) gradation requirements:

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
3 inch	100
2 inch	90 to 100
1/4-inch	30 to 65
#40	5 to 40
#200	0 to 10

F. Granular Fill: Import all granular fill types from off-site sources. Granular fill consists of stone, sand, and gravel, or blends of these materials, free of slag, complying with New York State Department of Transportation (NYSDOT) Standard Specification, Section 304, as modified below:

1. Type 2 Fill (NYSDOT ITEM No. 304.12 / Crushed / Blasted Ledge Rock Stone) Gradation Requirements.

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
2 inch	100
1/4-inch	25 to 60
#40	5 to 40
#200	0 to 10

2. Type 4 Fill (NYSDOT ITEM No. 304.14 / Select Granular Fill) Gradation Requirements.

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
2 inch	100
1/4-inch	30 to 65
#40	5 to 40
#200	0 to 10

G. Crushed Stone: Crushed stone to complying with New York State Department of Transportation (NYSDOT) Standard Specifications, Section 703-0201 which is product of mechanical crushing. Where indicated, provide the following fill materials, consisting of clean, free of slag, durable, sharp-angled fragments of rock of uniform quality. The crushed stone used as coarse aggregate for all items shall be obtained from sources conforming to the requirements of the NYSDOT as to sampling, testing methods, Quarry Reports and any other required procedures and complying with following requirements:

1. NYSDOT No. 1 Crushed Stone Gradation Requirements (NYSDOT 703-4 # 1 Stone):

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1 inch	100
1/2-inch	90 to 100
1/4-inch	0 to 15
#200	0 to 1

2. NYSDOT No. 2 Crushed Stone Gradation Requirements (NYSDOT 703-4 #2 Stone):

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1-1/2 inch	100
1 inch	90 to 100
1/2-inch	0 to 15
#200	0 to 1

H. Drainage Fill: Mixture of 50 percent NYSDOT No. 1 crushed stone and 50 percent NYSDOT No. 2 crushed stone, complying with New York State Department of Transportation Standard Specifications, Section 703-02.

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1-1/2 inch	100
1 inch	95 to 100
1/2-inch	25 to 60
# 4	0 to 10
# 8	0 to 5

I. Pea Gravel (For Fuel Oil Tank Backfill) Gradation Requirements:

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1 inch	100
3/4-inch	90 to 100
1/2-inch	20 to 55
3/8-inch	0 to 15
#4	0 to 5

J. Sand for general use and/or utility bedding: ASTM C 33; fine aggregate.

K. Sand for storm water quality sand filter: Clean (washed) AASHTO M-6/ASTM C-33 medium aggregate coarse concrete sand, with effective particle size (D10) between 0.3mm and 0.5mm, a uniformity coefficient (Uc) of < 4, and < 4% fines passing the 100 sieve.

L. Coarse Sand for Athletic Field Slit Drains: Approximate particle size of between 1.0 and 2.0 mm. When passed over a sieve, coarse sand will have:

1. Less than 5 percent retained on a #10 U S standard sieve,
2. Less than 5 percent passing a #30 U S standard sieve
3. In no case should more than 1 percent pass through a #50 U S standard sieve.

M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Separation/Filter Fabric - Nonwoven needle-punched polypropylene geotextile filter/separation fabric complying with the following:

Fabric Property	**Value**	**Test Method**
Grab Tensile Strength	120 lb	ASTM D 4632
Grab Tensile Elongation	50 percent	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4533
CBR Puncture Strength	310 lbs min	ASTM D 6241
Apparent Opening Size	No. 70 sieve max	ASTM D 4751
Permittivity	1.7 sec^{-1}	ASTM D 4491
Flow Rate	135 gal min/ft^2	ASTM D 4491
UV Stability	70% after 500 hours	ASTM D 4355

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. TenCate Mirafi - 140N
   b. Amoco - 4547
   c. Geotex – 451

B. Soil Stabilization Fabric: Heavy duty, commercially manufactured woven polypropylene geotextile meeting the following properties:

Fabric Property	**Test Method**	**Unit**	**Typical Value**
Grab Tensile Strength	ASTM D 4632	lbs	200
Grab Tensile Elongation	ASTM D 4632	%	15
Trapezoidal Tear Strength	ASTM D 4533	lbs	75 min.
CBR Puncture Strength	ASTM D 6241	lbs	700
UV Resistant after 500 hours	ASTM D 4355	% Strength	70
Apparent Opening Size	ASTM D 4751	US Sieve	40
Permittivity	ASTM D 4491	sec^{-1}	0.05
Water Flow Rate	ASTM D 4491	gal/min/ft^2	4.0

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. TenCate Mirafi - 500X
   b. US Fabrics, Inc. - US 200
   c. Carthage Mills – FX-55
   d. Propex – 200 ST

C. Subsurface Drainage Geotextiles: Refer to Division 33 Section "Storm Utility Drainage Piping".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with earthwork until unsatisfactory conditions have been corrected in manner acceptable to Installer.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

1. Contractor is entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

2. Contractors are advised that they are required to comply with Occupational Safety and Health Administration’s (OSHA) standards pertaining to excavation.

3. All excavations must be barricaded at all times using either traffic or A-Frame type barricades. Gaps between barricades may be up to 6-inches wide and must be blocked with caution tape.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.3 UNDERGROUND UTILITY SURVEY

A. An underground utility survey must be conducted prior to the start of any excavation. Call 811

3.4 DEWATERING

A. Refer to Division 31 Section “Dewatering”.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.5 EXPLOSIVES

A. Explosives: Do not use explosives.

3.6 SITE CLEARING

A. Refer to Division 31 Section "Site Clearing”.

3.7 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Geotechnical Engineer. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock (refer to Definitions section: “Rock” paragraph above). Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.8 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

a. See Structural Drawings for specific removal and replacement instructions if required.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Protect trees and other plants in accordance with requirements in Division 1 Section "Temporary Facilities and Controls" and Division 31 Section “Erosion and Sedimentation Control”.

3.9 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.10 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 6 inches (150 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Remove projecting stones and sharp objects along trench subgrade.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots in accordance with standard nursery practice and Division 31 Section “Erosion and Sedimentation Control”.

3.11 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.
B. If Geotechnical Engineer determines that unsuitable soil is present, continue excavation and replace with compacted backfill or fill material as directed.

3.12 PROOF-ROLLING

A. Proof-roll subgrade below building slabs, concrete pads and pavements by making a minimum of four (4) passes in two perpendicular directions with a 10-ton roller, or a 1.5-ton trench roller, where access is confined. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction and repeating proof-rolling in direction perpendicular to first direction with a minimum of four overlapping passes.

2. Excavate soft spots, unsuitable soils, and areas of excessive pumping or rutting, as identified by Geotechnical Engineer and as directed by Owner, and replace with compacted backfill or fill as directed. Notify Architect in writing of any required remediation.

3. Foundations: Proof-roll prior to excavation for foundations but after top soil is stripped.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities without additional compensation.

3.13 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. CLSM (flowable fill), per this specification section, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit in accordance with this Section unless otherwise directed by Geotechnical Engineer.

3.14 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.15 SOIL STABILIZATION FABRIC

A. Install soil stabilization fabric: After subgrade has been compacted and proof-rolled, install soil stabilization fabric as specified by the manufacturer, including the following:

1. Lay fabric in the direction of traffic.
2. Overlap fabric side to side and end to end a minimum of two feet.
3. Insure that fabric lies flat during fill placement.

3.16 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.17 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.18 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows. Refer to Part 2 for material requirements and specific conditions for the use of each type of soil material. All fill materials to be approved by Architect per requirements noted in Part 2.

1. Under grass and planted areas:

a. Use satisfactory non-granular fill material.

2. Under walks, pavements and exterior slabs:

a. Use Structural Fill below subbase layer and Type 2 granular fill for subbase layer.

3. Under steps and ramps

a. Use structural fill below subbase layer and Type 2 granular fill for subbase layer.

4. Under building slabs:

a. Use structural fill below subbase layer. For subbase, use No. 2 Crushed Stone. See Drawings for depth.

5. Under footings and foundations:

a. Use structural fill.

6. Under catch basins, manholes, vaults or other underground structures.

a. Use structural fill or as noted on drawings.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.19 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry density.

3.20 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Maximum layer depth before compaction:

1. Under Pavement: Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry weight density according to ASTM D 1557:

1. Under structures, building slabs, steps, synthetic turf and pavements:

a. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways:

a. Scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.

3. Under natural turf or unpaved areas:

a. Compact each layer of subgrade backfill or fill soil material at 85 percent. Compact all layers beneath the upper 2'-0" to at least 95 percent.

4. Utility trenches:

a. Compact each layer of initial and final backfill soil material at 85 percent.

5. Landscape Planting Areas:

a. Compact each layer of subgrade backfill or fill soil material at 75 percent.

6. Under catch basins, manholes, vaults or other underground structures.

a. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.21 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge and within +0" / -1" tolerance of bottom of slab.

3.22 SUBSURFACE DRAINAGE

A. Drainage Tubing / Subdrainage Pipe: Specified in Division 33 Section "Storm Utility Drainage Piping".

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench as shown in Drawings.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

3.23 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place granular fill base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place granular fill base course under pavements and walks as follows:

1. Place base course material over subgrade under hot-mix asphalt pavement.

a. If separation geotextile is shown in details, install on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Shape base course to required crown elevations and cross-slope grades.

3. Place base course 6 inches or less in compacted thickness in a single layer.

4. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

5. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.24 SUB BASE FOR CONCRETE SLABS-ON-GRADE

A. Place sub base on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact sub base under cast-in-place concrete slabs-on-grade as follows:

1. Place sub base 8 inches or less in compacted thickness in a single layer.
2. Place sub base that exceeds 8 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 8 inches thick or less than 3 inches thick.
3. Compact each layer of sub base to required cross sections and thicknesses to not less than 95 percent of maximum dry density according to ASTM D 4254.

3.25 INSTALLATION OF SURFACE STONE MATERIAL

A. Place surface stone material (stone dust, cover stone, etc.) on subgrades free of mud, frost, snow, or ice.

B. Compact so that surface stone layer is consolidated. During installation avoid bringing subgrade material to the surface. If subgrade material becomes intermixed with surface stone, remove contaminated surface stone material and reinstall new surface stone.

3.26 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections unless otherwise noted.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Inspections and tests:

1. Geotechnical observations: Proof rolling procedures, site preparation, unsuitable soils removal, excavations, footing bearing, and fill placement.

2. Field Density Testing:

a. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Geotechnical Engineer.

b. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1) Fill under Footings: In each compacted fill layer, 1 compaction test for every 30 linear feet of wall may be taken. 1 compaction test may be made under each individual footing.

2) Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 feet or less of wall length, but no fewer than two tests.

3) Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

4) Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

c. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.27 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Geotechnical Engineer or Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.28 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

GEOTECHNICAL BORING MAPS AND LOGS

Appendix to Project Manual Section 31 20 00, EARTH MOVING

Tectonic

PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.

GEOTECHNICAL EVALUATION
PROPOSED SITE IMPROVEMENTS
WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL AND CLARE F. OSTRANDER ELEMENTARY SCHOOL
90 ROBINSON DRIVE AND 137 VIOLA AVENUE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NEW YORK

Submitted To:

Wallkill Central School District

1500 Route 208,
Wallkill, New York 12589

September 12, 2022

W.O. 11476.01

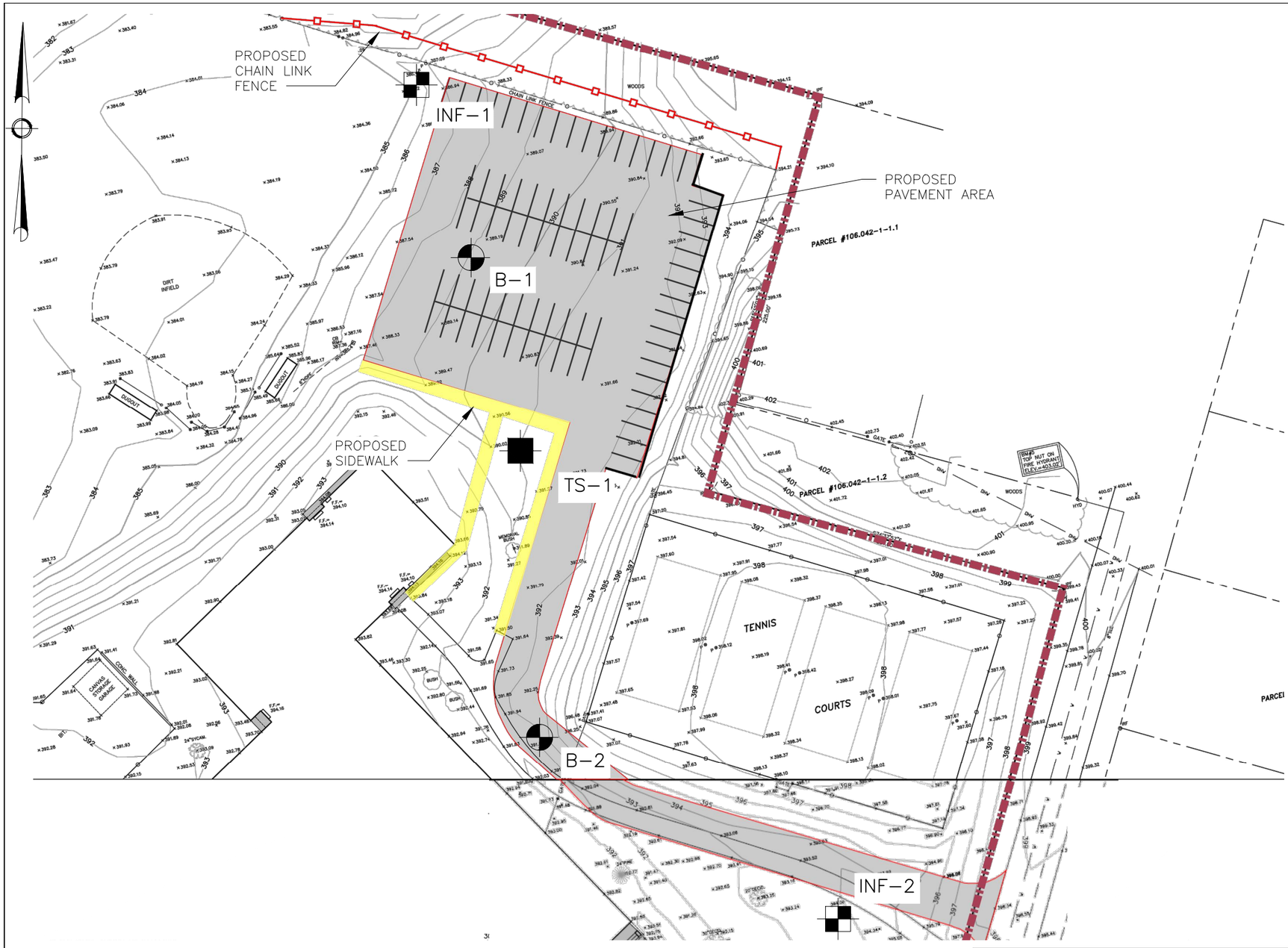
Submitted By:

Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.

1279 Route 300, 2nd Floor
Newburgh, NY 12550

(P) 845.567.6656
(F) 845.567.6248

FIGURES



LEGEND

B–11	APPROXIMATE BORING LOCATION
PB–3	APPROXIMATE PAVEMENT BORING LOCATION
INF–15	APPROXIMATE INFILTRATION TEST LOCATION
TS–6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

SITE

0 1 2 3

ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.
Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road
P.O. Box 37
Mountainville, NY 10953
Phone: (845) 534–5959
(800) 829–6531
www.tectonicengineering.com
Project Contact Info
1279 Route 300
Newburgh, NY 12550
Phone: (845) 567–6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL
90 ROBINSON DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 1	0
Scale 1" = 60'			

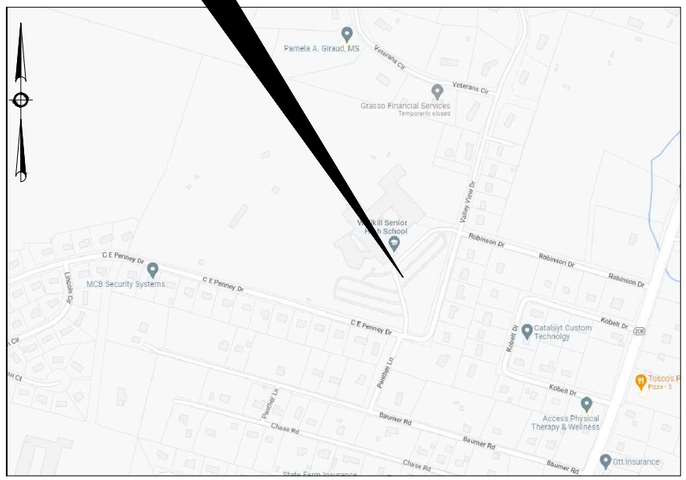
LEGEND

B-11	APPROXIMATE BORING LOCATION
PB-3	APPROXIMATE PAVEMENT BORING LOCATION
INF-15	APPROXIMATE INFILTRATION TEST LOCATION
TS-6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

SITE



0 1 2 3

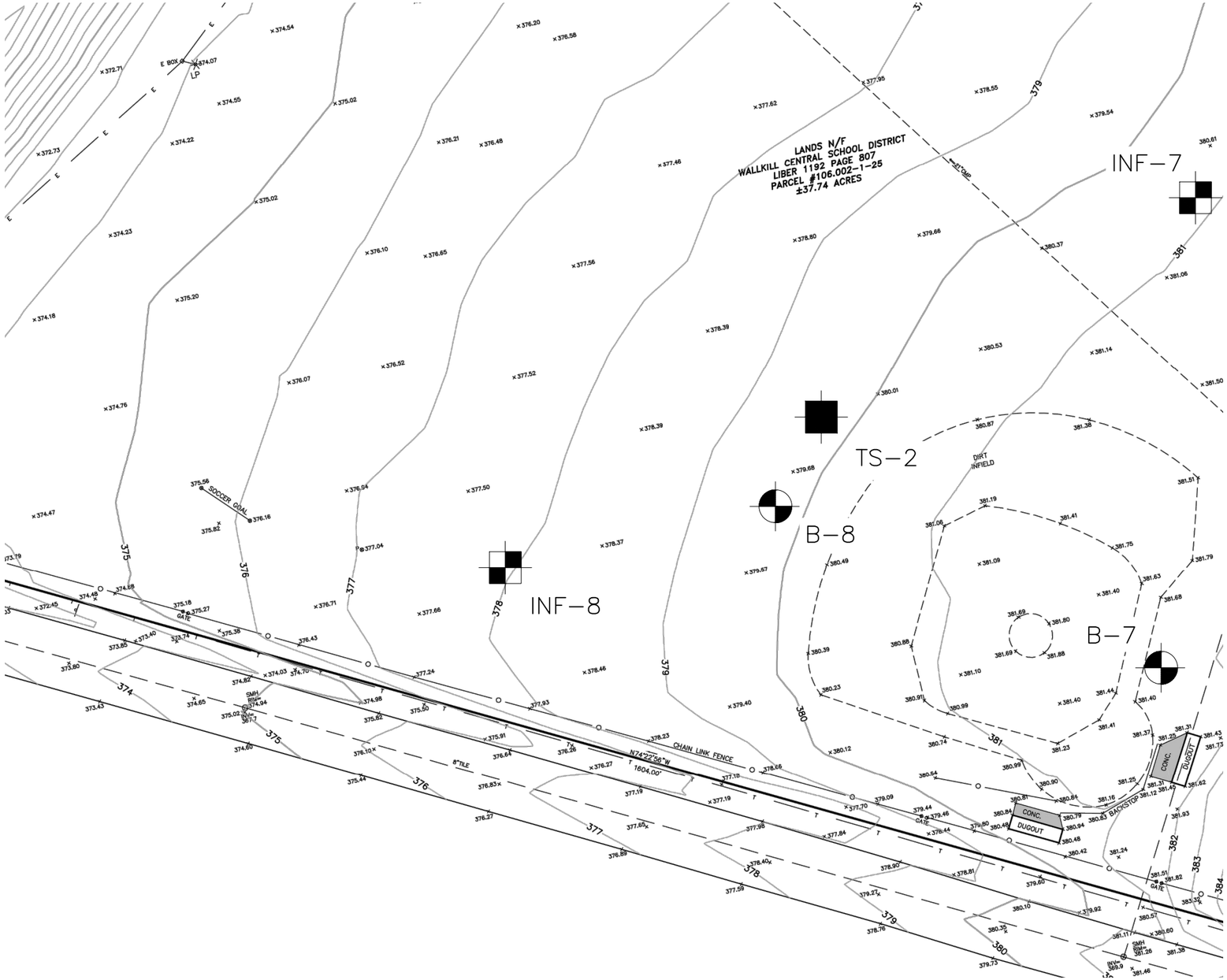
ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.
Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road
P.O. Box 37
Mountainville, NY 10953
Phone: (845) 534-5959
(800) 829-6531
www.tectonicengineering.com
Project Contact Info
1279 Route 300
Newburgh, NY 12550
Phone: (845) 567-6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL
90 ROBINSON DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 2	0
Scale 1" = 80'			



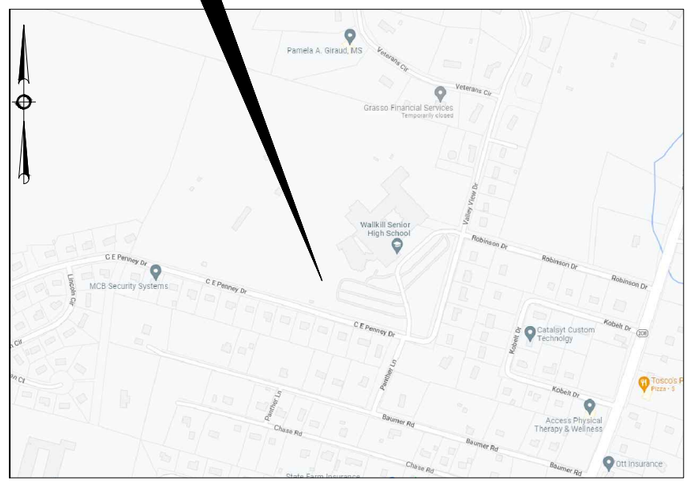
LEGEND

B-11	APPROXIMATE BORING LOCATION
PB-3	APPROXIMATE PAVEMENT BORING LOCATION
INF-15	APPROXIMATE INFILTRATION TEST LOCATION
TS-6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

SITE



0 1 2 3

ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.
Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road
P.O. Box 37
Mountainville, NY 10953
Phone: (845) 534-5959
(800) 829-6531
www.tectonicengineering.com
Project Contact Info
1279 Route 300
Newburgh, NY 12550
Phone: (845) 567-6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL
90 ROBINSON DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 3	0
Scale 1" = 50'			

LEGEND

B-11	APPROXIMATE BORING LOCATION
PB-3	APPROXIMATE PAVEMENT BORING LOCATION
INF-15	APPROXIMATE INFILTRATION TEST LOCATION
TS-6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

PARCEL #106.002-1-36.25

PARCEL #106.042-1-2

PARCEL #106.042-1-3

PARCEL #106.042-1-4

CEL #106.042-1-1.1

#106.042-1-1.2

TS-4

INF-9

TS-5

BM#5 TOP NUT ON FIRE HYDRANT ELEV.=403.02'

S74°40'46"E 137.39'

S17°05'08"W 202.50'

GATE

WOODS

BRUSH

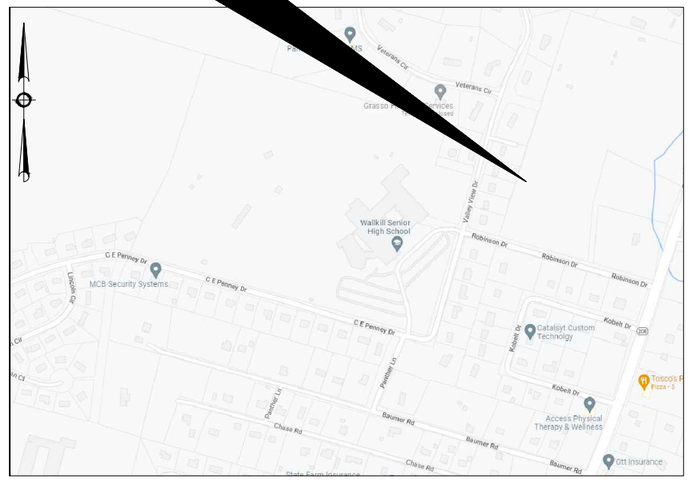
CHAIN LINK FENCE

POLE WIRE REMAINS

IRF

IPF

SITE



0 1 2 3

ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.
Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road
P.O. Box 37
Mountainville, NY 10953
Phone: (845) 534-5959
(800) 829-6531
www.tectonicengineering.com
Project Contact Info
1279 Route 300
Newburgh, NY 12550
Phone: (845) 567-6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL
90 ROBINSON DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 4	0
Scale: 1" = 50'			

LEGEND

B-11	APPROXIMATE BORING LOCATION
PB-3	APPROXIMATE PAVEMENT BORING LOCATION
INF-15	APPROXIMATE INFILTRATION TEST LOCATION
TS-6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

SITE

0 1 2 3

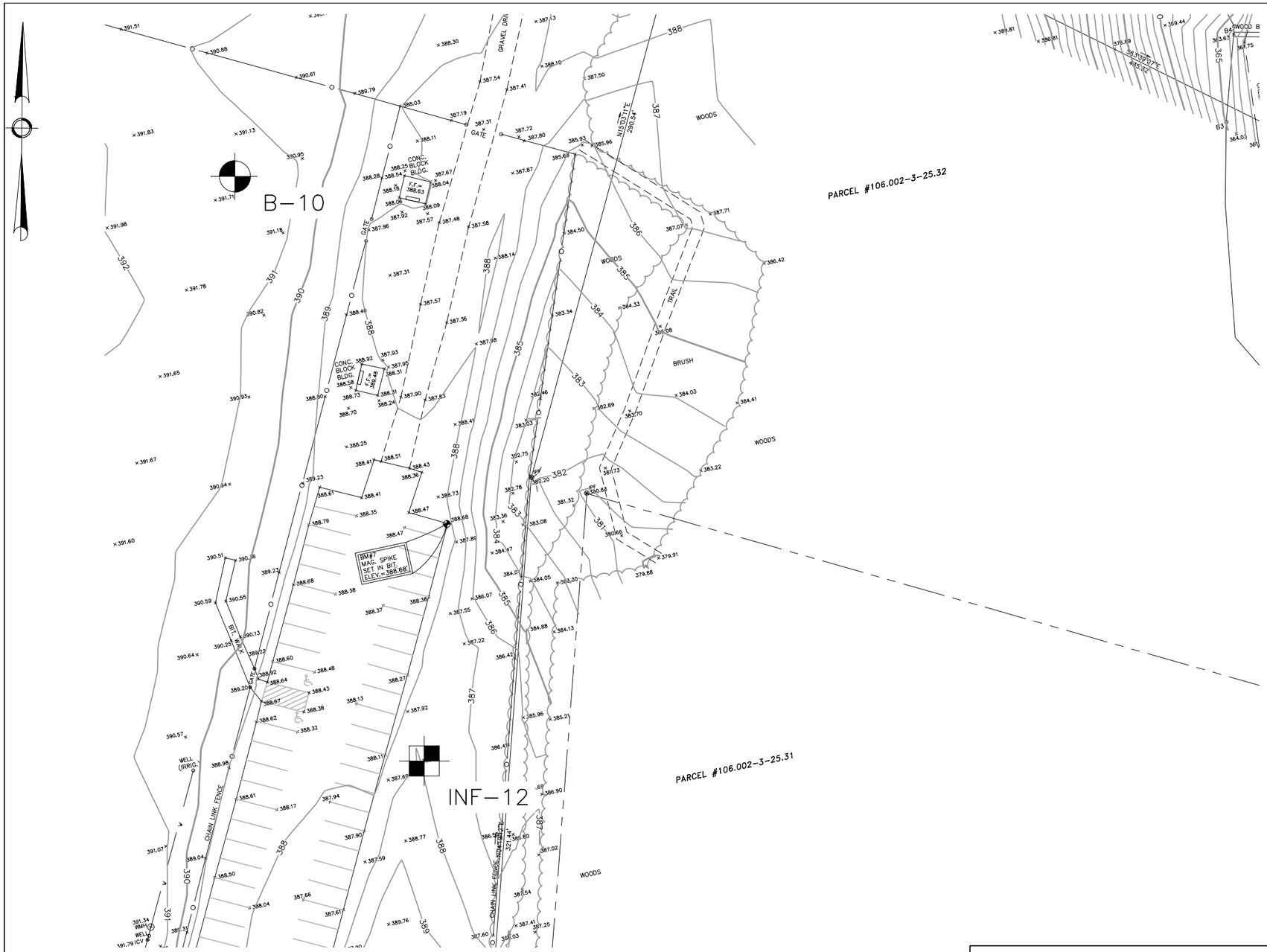
ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.
Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road — Phone: (845) 534-5959
P.O. Box 37 — (800) 829-6531
Mountainville, NY 10953 — www.tectonicengineering.com
Project Contact Info
1279 Route 300
Newburgh, NY 12550 — Phone: (845) 567-6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL
90 ROBINSON DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 5	0
Scale: 1" = 50'			



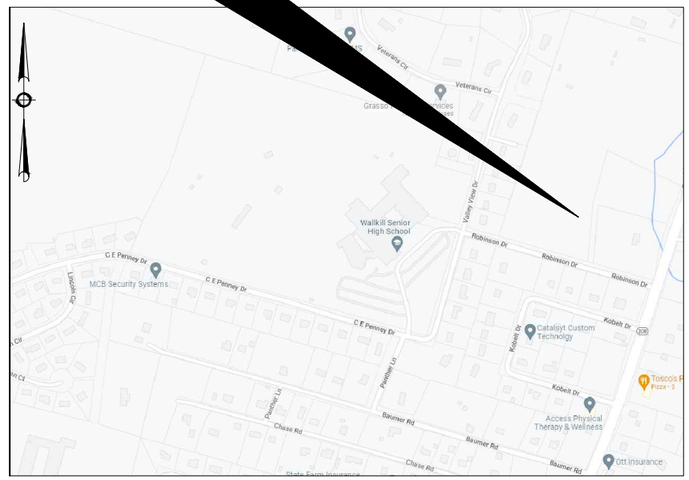
LEGEND

B-11	APPROXIMATE BORING LOCATION
PB-3	APPROXIMATE PAVEMENT BORING LOCATION
INF-15	APPROXIMATE INFILTRATION TEST LOCATION
TS-6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

SITE



0 1 2 3

ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.

Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road
P.O. Box 37
Mountainville, NY 10953
Phone: (845) 534-5959
(800) 829-6531
www.tectonicengineering.com

Project Contact Info
1279 Route 300
Newburgh, NY 12550
Phone: (845) 567-6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
WALLKILL HIGH SCHOOL
90 ROBINSON DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 6	0
Scale 1" = 50'			

REMOVE AND REPLACE ASPHALT SIDEWALK WITH A NEW 10 FT WIDE SIDEWALK

INF-13

REMOVE AND REPLACE SUNKEN CATCH BASIN

INF-15

REMOVE AND REPLACE CONCRETE SIDEWALK

REMOVE AND REPLACE CONCRETE SIDEWALK

PB-3

REMOVE AND REPLACE PLAYGROUND EQUIPMENT AND SURFACE

B-11

TS-6

6 IN UNDERDRAIN WITHIN STONE BED (TYP)

INF-14

12 IN HDPE PIPE. CONNECT TO DOWN STREAM CATCH BASIN

CLARE F. OSTRANDER ELEMENTARY SCHOOL

COURTYARD

LANDS N/F SHERRY BOOK 1668 PAGE 242 PARCEL#106.050-3-25

LANDS N/F SANTIAMAGRO BOOK 1344 PAGE 158 PARCEL#106.050-3-26

LANDS N/F O'BOY BOOK 3027 PAGE 25 PARCEL#106.050-3-2

LANDS N/F CARPENTER II

LANDS N/F KEARNS JR.

LANDS N/F COATES

LANDS N/F DOWNIGUES

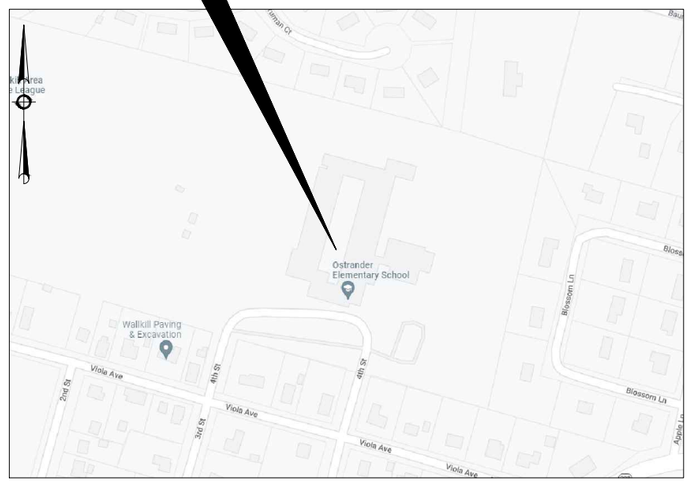
LEGEND

B-11	APPROXIMATE BORING LOCATION
PB-3	APPROXIMATE PAVEMENT BORING LOCATION
INF-15	APPROXIMATE INFILTRATION TEST LOCATION
TS-6	APPROXIMATE AREA OF TOPSOIL GRAB SAMPLE LOCATION

NOTES

1. PLAN BASED ON A SURVEYS PROVIDED BY BOLTON LAND SURVEYING, P.C., TITLED TOPOGRAPHIC SURVEY WALLKILL HIGH SCHOOL, AND BOUNDARY & TOPOGRAPHIC SURVEY OF A PORTION OF CLARE F. OSTRANDER ELEMENTARY SCHOOL, DATED 05/02/2007 AND 06/24/2014.
2. BORING, INFILTRATION, AND TOPSOIL TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC AND SHOULD BE CONSIDERED APPROXIMATE.

SITE



0 1 2 3

ORIGINAL SIZE IN INCHES

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.
Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C.
70 Pleasant Hill Road
P.O. Box 37
Mountainville, NY 10953
Phone: (845) 534-5959
(800) 829-6531
www.tectonicengineering.com
Project Contact Info
1279 Route 300
Newburgh, NY 12550
Phone: (845) 567-6656

BORING, INFILTRATION, AND TOPSOIL TEST LOCATION PLAN

WALLKILL CENTRAL SCHOOL DISTRICT
CLARE F. OSTRANDER ELEMENTARY SCHOOL
137 VIOLA DRIVE
TOWN OF SHAWANGUNK, ULSTER COUNTY, NY

Date	Work Order	Drawing No.	Rev
08/03/2022	11476.01	FIGURE 7	0
Scale 1" = 80'			

APPENDIX I

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-1

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER

DATE	TIME	DEPTH
6/27/22	**9:45 am**	**8'**

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Ryan Villa**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **389.0**
DATUM: **See Remarks**
DATE START: **6/27/22**
DATE FINISH: **6/27/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	12	2 6 6 7	S-1	18		M	SM	3" topsoil-like material Bwn c-f SAND, and Silt, some f Gravel		
3	6	3 2 4 30	S-2	14		M	SM	Bwn m-f SAND, and Silt, little c-f Gravel		
5	11	3 5 6 8	S-3	12		M	ML	Bwn SILT, little c-f Gravel, trace f Sand		384.0
7	17	9 9 8 8	S-4	16		M	SM	Bwn f SAND, some Silt, trace f Gravel		
9	17	7 8 9 9	S-5	20		W	SM	Bwn f SAND, and Silt		379.0
10								End of Boring at 10'		
15										374.0
20										369.0
25										364.0

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-2

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **9.5'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
6/27/22 | | **NE**

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Ryan Villa**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **392.0**
DATUM: **See Remarks**
DATE START: **6/27/22**
DATE FINISH: **6/27/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	28	2, 11, 17, 12	S-1	18		M	SM	3" topsoil-like material Bwn m-f SAND, some f Gravel, little Silt		
3	13	6, 8, 5, 8	S-2	20		M	SM	Bwn m-f SAND, and Silt, little c-f Gravel		
5	54	5, 10, 44, 34	S-3	20		M	SM GP-GM	10" Bwn m-f SAND, and c-f Gravel, little Silt 10" Blk c-f GRAVEL, trace m-f Sand, trace Silt		387.0
7	37	10, 14, 23, 21	S-4	18		M	SM	Bwn m-f SAND, some Silt, little c-f Gravel		
9	81+	12, 31, 50/5	S-5	16		M	GM	Blk-bwn c-f GRAVEL, and m-f Sand, little Silt		81
10								End of Boring at 9.5'		382.0
15										377.0
20										372.0
25										367.0

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-3

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/27/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Ryan Villa**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **394.0**
DATUM: **See Remarks**
DATE START: **6/27/22**
DATE FINISH: **6/27/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % × | WATER CONTENT % ⊗ | LIQUID LIMIT % △ 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	7	17 4 3 2	S-1	12		M	SM	3" asphalt pavement, 4" subbase gravel Bwn c-f SAND, some c-f Gravel, little Silt (FILL)		
3	13	6 6 7 10	S-2	20		M	SM	Bwn c-f SAND, and Silt, little c-f Gravel (FILL)		
5	44	16 22 22 22	S-3	18		M	SM	3" Bwn c-f SAND, and Silt, little c-f Gravel		389.0
6							GM	Blk-bwn c-f GRAVEL, some c-f Sand, little Silt		
7	26	14 13 13 10	S-4	22		M	GM	Blk-bwn c-f GRAVEL, some c-f Sand, little Silt		
9	27	10 15 12 21	S-5	6		M	SM	Bwn m-f SAND, and Silt, trace f Gravel		384.0
10								End of Boring at 10'		
15										379.0
20										374.0
25										369.0

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-4

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/27/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **R. Villa/ Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **391.0**
DATUM: **See Remarks**
DATE START: **6/27/22**
DATE FINISH: **6/27/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ◓ 1 2 3 4 5
PLASTIC LIMIT % ⊗ WATER CONTENT % △ LIQUID LIMIT % 10 20 30 40 50
● STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
0								3" asphalt pavement, 3" gravel subbase		391.0
1	11	16 7 4 4	S-1	12		M	SM	Bwn c-m SAND, and Silt, some f Gravel (FILL)		
2										
3	11	3 5 6 8	S-2	24		M	SM	Bwn c-f SAND, and Silt, trace f Gravel (FILL)		
4										
5	50	11 23 27 25	S-3	20		M	GM	Bwn-blk c-f GRAVEL, and c-f Sand, little Silt		386.0
6										
7	43	15 20 23 24	S-4	24		M	GM	Same		
8										
9	38	14 18 20 19	S-5			M	GM	Same		
10										381.0
11								End of Boring at 10'		
12										
13										
14										
15										376.0
16										
17										
18										
19										
20										371.0
21										
22										
23										
24										
25										366.0

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-5

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
6/28/22 | | **NE**

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **394.0**
DATUM: **See Remarks**
DATE START: **6/28/22**
DATE FINISH: **6/28/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	30	34 14 16 16	S-1	24		M	SP-SM	3" asphalt pavement, 4" gravel subbase Blk-bwn c-f SAND, and c-f Gravel, little Silt (FILL)		
3	23	10 10 13 13	S-2	22		M	SP-SM	Same (FILL)		
5	11	9 5 6 7	S-3	16		M	SM	Bwn c-f SAND, little f Gravel, little Silt (FILL)		389.0
7	13	6 8 5 5	S-4	16		M	SM	Bwn m-f SAND, some c-f Gravel, some Silt		
9	33	10 15 18 18	S-5	18		M	SM	Same		384.0
10								End of Boring at 10'		
15										379.0
20										374.0
25										369.0

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-6

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/28/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **390.1**
DATUM: **See Remarks**
DATE START: **6/28/22**
DATE FINISH: **6/28/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	15	26 7 8 7	S-1	16		M	GM	3" asphalt pavement, 6" gravel subbase Bwn c-f GRAVEL, and c-f Sand, little Silt (FILL)		
3	20	9 8 12 8	S-2	22		M	GM	Same		
5	17	9 8 9 11	S-3	24		M	GM	Blk-bwn c-f GRAVEL, some c-f Sand, some Silt		385.1
7	19	11 10 9 7	S-4	12		M	SM	Bwn m-f SAND, some c-f Gravel, some Silt		
9	60	9 40 20 17	S-5	24		M	SM	Same		380.1
10								End of Boring at 10'		
15										375.1
20										370.1
25										365.1

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-7

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/28/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Clear** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **381.4**
DATUM: **See Remarks**
DATE START: **6/28/22**
DATE FINISH: **6/28/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) 1 2 3 4 5
PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	11	2, 3, 8, 9	S-1	24		M	SM	2" topsoil-like material Bwn c-f SAND, little c-f Gravel, little Silt (FILL)		
3	27	8, 10, 17, 14	S-2	20		M	GP-GM	Blk c-f GRAVEL, some m Sand, little Silt		
5	42	9, 24, 18, 19	S-3	4		M	GP-GM	Same		376.4
7	27	11, 13, 14, 10	S-4	0				No Recovery		
9	23	7, 12, 11, 13	S-5	10		M	GP-GM	Blk-bwn-wht c-f GRAVEL, some c-f Sand, little Silt		371.4
10								End of Boring at 10'		
15										366.4
20										361.4
25										356.4

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-8

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/28/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Clear** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **379.7**
DATUM: **See Remarks**
DATE START: **6/28/22**
DATE FINISH: **6/28/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % ✕ ⊗ △ 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	5	1 3 2 4	S-1	14		M	SM	3" topsoil-like material Bwn c-f SAND, little f Gravel, little Silt (FILL)		
3	24	8 11 13 15	S-2	24		M	SM	Bwn c-f SAND, some f Gravel, little Silt		
5	27	10 12 15 17	S-3	10		M	GM	Blk-bwn c-f GRAVEL, and c-f Sand, little Silt		374.7
7	22	9 11 11 4	S-4	16		M	GM	Bwn-gy m-f SAND, some c-f Gravel, some Silt		
9	15	5 8 7 12	S-5	24		M	SM	Bwn-gy f SAND, and Silt		369.7
10								End of Boring at 10'		
15										364.7
20										359.7
25										354.7

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-9

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
6/29/22 | | **NE**

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Clear** TEMP: **85° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **392.3**
DATUM: **See Remarks**
DATE START: **6/29/22**
DATE FINISH: **6/29/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT %
10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	11	2 7 4 2	S-1	18		M	ML	2" topsoil-like material Bwn SILT, some f Sand, little f Gravel		
3	5	1 2 3 3	S-2	16		M	SM	Bwn m-f SAND, some c-f Gravel, some Silt		
5	9	3 2 7 10	S-3	14		M	SM	Bwn c-f SAND, some c-f Gravel, little Silt		387.3
7	13	7 8 5 3	S-4	16		M	SM	Same		
9	11	5 5 6 6	S-5	14		M	GM	Blk-bwn c-f GRAVEL, and c-f Sand, little Silt		
10								End of Boring at 10'		382.3
15										377.3
20										372.3
25										367.3

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

BORING No. B-10

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**
SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/29/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Clear** TEMP: **80° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **391.7**
DATUM: **See Remarks**
DATE START: **6/29/22**
DATE FINISH: **6/29/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % ✕ ⊗ △ 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	22	2 10 12 9	S-1	16		M	SM	2" topsoil-like material Bwn c-f SAND, some c-f Gravel, little Silt		
3	0	2 WOH WOH WOH	S-2	6		M	SM	Bwn m-f SAND, some Silt, some c-f Gravel		
5	3	4 2 1 1	S-3	6		M	SM	Bwn m-f SAND, some Silt, little c-f Gravel		386.7
7	6	3 3 3 2	S-4	12		M	SM SM	2" Bwn m-f SAND, little c-f Gravel, little Silt Gy m-f SAND, and Silt		
9	16	5 6 10 13	S-5			M	SM SM	Gy m-f SAND, and Silt Bwn c-f SAND, little c-f Gravel, little Silt		381.7
10								End of Boring at 10'		
15										376.7
20										371.7
25										366.7

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. B-11

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **10'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/29/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Clear** TEMP: **80° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **340.0**
DATUM: **See Remarks**
DATE START: **6/29/22**
DATE FINISH: **6/29/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV. LENGTH (IN.)	RECOV. RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1	10	2, 4, 6, 7	S-1	18		M	ML	3" topsoil-like material Bwn SILT, little f Sand, trace f Gravel		
3	20	5, 10, 10, 10	S-2	18		M	SM	Same		
5	14	8, 8, 6, 7	S-3	22		M	SM	Bwn m-f SAND, and Silt		335.0
7	23	8, 10, 13, 14	S-4	24		M	SM	Same		
9	38	13, 18, 20, 20	S-5	22		M	SM	Same		330.0
10								End of Boring at 10'		
15										325.0
20										320.0
25										315.0

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Clare F. Ostrander Elementary School", dated May 2007.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. PB-1

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: **3 1/4"** **0** TO **0.75'**
ROT. DRILL: TO
CASING: TO
DIAMOND CORE: TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER

DATE	TIME	DEPTH
6/27/22		**NE**

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: **---** TO **---**
WEATHER: **Overcast** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **Ryan Villa**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **398.6**
DATUM: **See Remarks**
DATE START: **6/27/22**
DATE FINISH: **6/27/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ◓ — 1 2 3 4 5
PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % — 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● — 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	SAMPLES: RECOV. LENGTH (IN.)	SAMPLES: RECOV. RQD (%)	SAMPLES: MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1								3" asphalt pavement 5" 1/2" gravel Subbase Bwn m-f SAND, little c-f Gravel, little Silt (FILL)		
2										
3										
4										
5										393.6
6										
7										
8										
9										
10										388.6
11										
12										
13										
14										
15										383.6
16										
17										
18										
19										
20										378.6
21										
22										
23										
24										
25								End of Boring at 0.75'		373.6

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. PB-2

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **1'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER | DATE | TIME | DEPTH
| **6/28/22** | | **NE**
| | | |

MON. WELL ☐ YES ☒ NO
SCREEN DEPTH: --- TO ---
WEATHER: **Clear** TEMP: **75° F**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

INSPECTOR: **R. Villa/ Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **381.3**
DATUM: **See Remarks**
DATE START: **6/28/22**
DATE FINISH: **6/28/22**

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ◓ 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT %
10 20 30 40 50
● STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV.: LENGTH (IN.)	RECOV.: RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1								2" asphalt pavement 6" 1/2" gravel subbase 4" Bwn m-f SAND, and c-f Gravel, little Silt (FILL)		
5										376.3
10										371.3
15										366.3
20										361.3
25								End of Boring at 1'		356.3

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Wallkill High School", dated June 2014.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic

PROJECT No. **11476.01**
PROJECT: **Wallkill CSD Site Improvements**
LOCATION: **Wallkill, NY**

BORING No. PB-3

SHEET No. 1 of 1

CLIENT: **Wallkill Central School District**
CONTRACTOR: **Core Down Drilling LLC**
METHOD OF ADVANCING BORING | DIA. | DEPTH
POWER AUGER: | **3 1/4"** | **0** TO **1'**
ROT. DRILL: | | TO
CASING: | | TO
DIAMOND CORE: | | TO
Geoprobe 7822DT with DH103 Automatic Hammer

GROUND WATER

DATE	TIME	DEPTH
6/29/22		**NE**

INSPECTOR: **Jesus R**
DRILLER: **Billy Johnson**
SURFACE ELEVATION: **316.0**
MON. WELL ☐ YES ☒ NO
DATUM: **See Remarks**
SCREEN DEPTH: **---** TO **---**
DATE START: **6/29/22**
WEATHER: **Clear** TEMP: **80° F**
DATE FINISH: **6/29/22**
DEPTH TO ROCK: **Not Encountered'**
*CHANGES IN STRATA ARE INFERRED

UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5
PLASTIC LIMIT % | WATER CONTENT % | LIQUID LIMIT % ✕ ⊗ △ 10 20 30 40 50
STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES: SAMPLE NUMBER	RECOV.: LENGTH (IN.)	RECOV.: RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
1								3" asphalt 6" gravel subbase 3" Bwn c-f SAND, and c-f Gravel, little Silt (FILL)		
2										
3										
4										
5										311.0
6										
7										
8										
9										
10										306.0
11										
12										
13										
14										
15										301.0
16										
17										
18										
19										
20										296.0
21										
22										
23										
24										
25										291.0

End of Boring at 1'

REMARKS: Surface elevations estimated based on a topographic survey provided by Bolton Land Surveying, P.C., entitled "Clare F. Ostrander Elementary School", dated May 2007.

BORING LOG 11476.01.GPJ TECTONIC ENG.GDT 9/12/22

Tectonic
PRACTICAL SOLUTIONS. EXCEPTIONAL SERVICE.

LEGEND FOR SOIL DESCRIPTION

COARSE GRAINED SOIL (Coarser then No. 200 Sieve)

DESCRIPTIVE TERM & GRAIN SIZE

TERM	SAND					GRAVEL
coarse - c	No.	4	Sieve to No.	10	Sieve	3" to 3/4"
medium - m	No.	10	Sieve to No.	40	Sieve	3/4" to 3/16"
fine - f	No,	40	Sieve to No.	200	Sieve	

COBBLES 3" to 10"

BOULDERS 10" +

GRADATION DESIGNATIONS	PROPORTIONS OF COMPONENT
fine, f	Less than 10% coarse to medium
medium to fine, m-f	Less than 10% coarse
medium, m	Less than 10% coarse and fine
coarse to medium, c-m	Less than 10% fine
coarse, c	Less than 10% medium and fine
coarse to fine, c-f	All greater than 10%

FINE GRAINED SOIL (Finer than No. 200 Sieve)

DESCRIPTION	PLASTICITY INDEX	PLASTICITY
Silt	0 - 1	none
Clayey Silt	2 - 5	slight
Silt & Clay	6 - 10	low
Clay & Silt	11 - 20	medium
Silty Clay	21 - 40	high
Clay	greater than 40	very high

PROPORTION

DESCRIPTIVE TERM	PERCENT OF SAMPLE WEIGHT
trace	1 - 10
little	10 - 20
some	20 - 35
and	35 - 50

The primary component is fully capitalized

COLOR

Blue - blue	Gy - gray	Wh - white
Blk - black	Or - orange	Yl - yellow
Bwn - brown	Rd - red	Lgt - light
Gn - green	Tn - tan	Dk - dark

SAMPLE NOTATION

S - Split Spoon Soil Sample
U - Undisturbed Tube Sample
C - Core Sample
B - Bulk Soil Sample
NR - No Recovery of Sample

WOC - Weight of Casing
WOR - Weight of Rods
WOH - Weight of Hammer
PPR - Compressive Strength based on Pocket Penetrometer
TV - Shear Strength (tsf) based on Torvane

ADDITIONAL CLASSIFICATIONS

New York City Building Code soil classifications are given in parentheses at the end of each description of material, if applicable. See sections 1804.2 of the 2008 Building Code for further details.

Tectonic

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 6/30/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-1	5'	4"	9:24 AM	24"	23"	20"	22"	24"		24.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-1 located adjacent to proposed parking lot to the northwest of the tennis courts.										
INF-2	5'	4"	9:39 AM	24"	11"	9"	6"	7"		7.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-2 located to the south of the tennis courts. Large stone observed at bottom of the pipe.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

Tectonic

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 6/30/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-3	5'	4"	9:43 AM	24"	7"	4"	3"	3.5"		3.5
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-3 located in landscape area on the eastern face of the high school, adjacent to the existing parking lot.										
INF-4	5'	4"	9:46 AM	24"	7"	5"	5"	5"		5.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-4 located in landscape area to the southeast of the high school parking lot.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 6/30/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Locations Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-5	5'	24"	9:55 AM	24"	10"	10"	10"	10"		10.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-5 located in landscape area to the south of the existing high school parking lot.										
INF-6	5'	24"	9:06 AM	24"	10"	11"	12"	12"		12.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-6 located in lcandscape area located to the southwest of the high school building.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

Tectonic

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 6/30/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Locations Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-5	5'	4"	9:55 AM	24"	10"	10"	10"	10"		10.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-5 located in landscape area to the south of the existing high school parking lot.										
INF-6	5'	4"	9:06 AM	24"	10"	11"	12"	12"		12.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-6 located in lcandscape area located to the southwest of the high school building.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 7/1/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Locations Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-9	5'	4"	8:14 AM	24"	12"	12"	10"	10"		10.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-9 located in the northwest corner of the high school soccer field.										
INF-10	5'	4"	8:12 AM	24"	15"	17"	17"	17"		17.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-10 located in the southwest corner of the high school soccer field.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 7/1/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-11	5'	4"	8:11 AM	24"	13"	13"	14"	10"		10.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-11 located in south-central portion of the high school soccer field.										
INF-12	5'	4"	8:07 AM	24"	24"	23"	23"	23"		23.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-12 located in landscape area to the east of the parking lot, adjacent to the high school soccer field.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 7/1/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-13	5'	4"	8:22 AM	24"	19"	20"	17"	17"		17.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-13 located in landscape area to the northwest of Ostrander Elementary School.										
INF-14	5'	4"	8:24 AM	24"	3"	1"	1"	1"		1.0
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		
COMMENTS: INF-14 located in landscape area to the east of Ostrander Elementary School.										

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

Tectonic

1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 11476.01 Lot No.: Date: 7/1/2022

Client: Wallkill CSD

Project: Wallkill CSD Site Improvements

Project Engineer: Scott Cohen, P.E.

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Clear Temperature: 75

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		PERCOLATION TEST RUNS Drop in water levels (inches) at 1 hour intervals						STABLE RATE (in/hr)
INF-15	5'	4"	8:25 AM	24"	4"	1"	2.5"	1.5"		1.5
			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		

COMMENTS:
INF-15 located within landscape area located to the east of Ostrander Elementary School. Infiltration test located in the footprint of an existing catch basin that is proposed to be replaced.

			TIME	0:00:00	1 hour	2 hours	3 hours	4 hours		

COMMENTS:

Sketch Requirements

(To Be Completed On Back of Sheet)

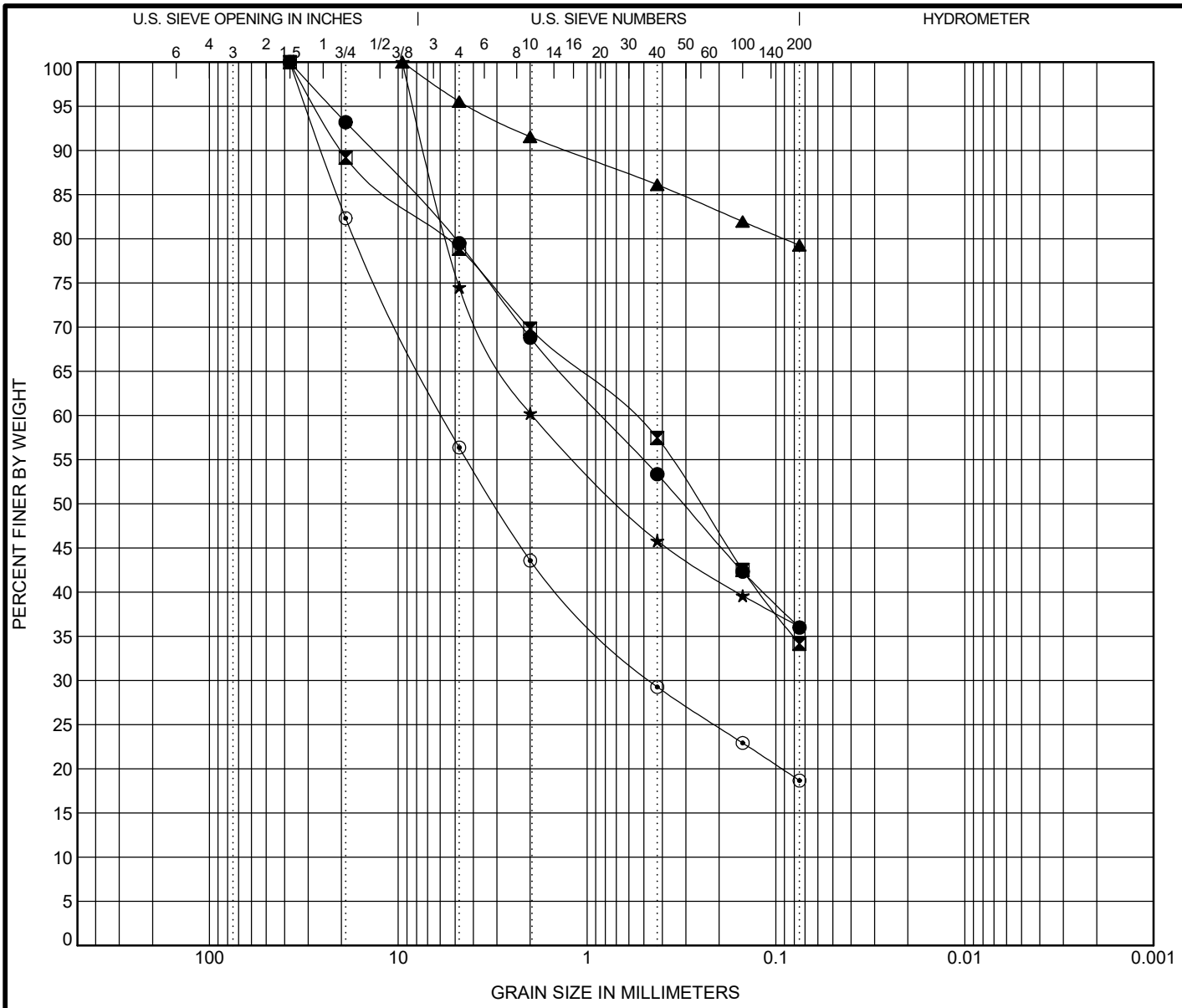
Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

APPENDIX II



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification			Classification	WC%	LL	PL	PI	Cc	Cu
●	B-1	0.0	S-1	Bwn c-f Sand, and Silt, some f Gravel	9.6					
⊠	B-10	2.0	S-2	Bwn m-f Sand, some Silt, some c-f Gravel	11.9					
▲	B-11	0.0	S-1	Bwn SILT, little f Sand, trace f Gravel	16.5					
★	B-4	0.0	S-1	Bwn c-m Sand, and Silt, some f Gravel	14.0					
⊙	B-6	0.0	S-1	Bwn c-f Gravel, and c-f Sand, little Silt	7.5					

	Sample Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	Source of Material
●	B-1	0.0	S-1	37.5	0.827			20.5	43.5	36.0		Boring
⊠	B-10	2.0	S-2	37.5	0.584			21.1	44.8	34.1		Boring
▲	B-11	0.0	S-1	9.5				4.5	16.3	79.3		Boring
★	B-4	0.0	S-1	9.5	1.952			25.5	38.4	36.1		Boring
⊙	B-6	0.0	S-1	37.5	5.766	0.461		43.6	37.7	18.7		Boring

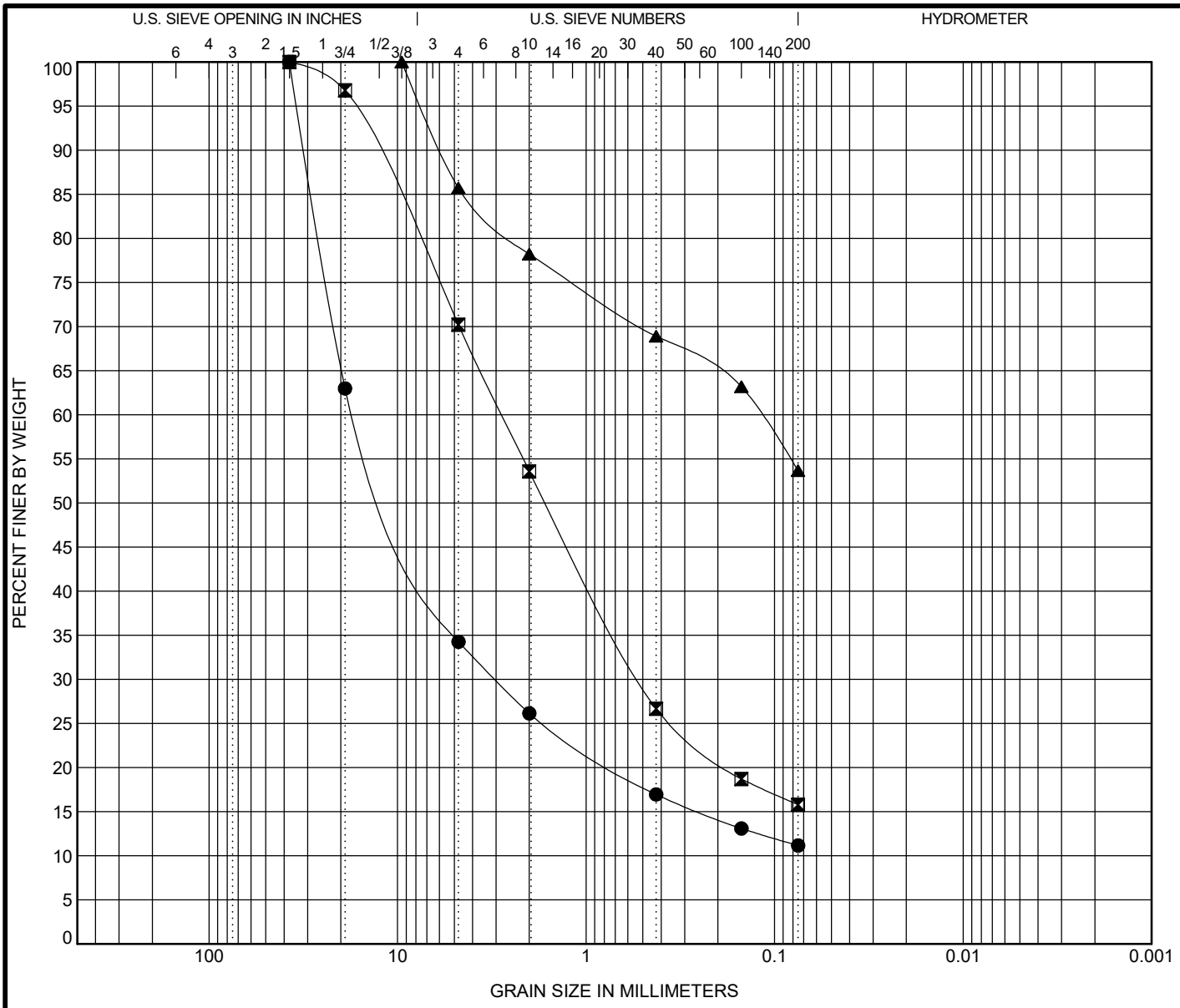
Tectonic
280 Little Britain Road, Bldg. 2
Newburgh, NY 12550
Telephone: (845) 563-9081 Fax: (845) 563-9085

GRAIN SIZE DISTRIBUTION

Project No: **11476.01** Date: **7/28/22**

Project: **Wallkill CSD**

Location: **Wallkill, NY**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification			Classification	WC%	LL	PL	PI	Cc	Cu
●	B-7	2.0	S-2	Blk c-f GRAVEL, some m Sand, little Silt	6.3				11.15	331.90
⊠	B-8	2.0	S-2	Bwn c-f SAND, some f Gravel, little Silt	7.2					
▲	B-9	0.0	S-1	Bwn SILT, some f Sand, little f Gravel	14.1					

	Sample Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	Source of Material
●	B-7	2.0	S-2	37.5	16.453	3.016		65.7	23.1	11.2		Boring
⊠	B-8	2.0	S-2	37.5	2.792	0.515		29.8	54.4	15.8		Boring
▲	B-9	0.0	S-1	9.5	0.119			14.3	32.1	53.7		Boring

Tectonic
280 Little Britain Road, Bldg. 2
Newburgh, NY 12550
Telephone: (845) 563-9081 Fax: (845) 563-9085

GRAIN SIZE DISTRIBUTION

Project No: **11476.01** Date: **7/28/22**

Project: **Wallkill CSD**

Location: **Wallkill, NY**

Turf & Soil Diagnostics

ACCREDITED TESTING Cert #0797.02

MATERIALS TEST REPORT FOR
Wallkill CSD - 11476.01

REPORT TO: Tectonic Engineering
Christopher Ferri
1279 Route 300, 2nd floor
Newburgh, NY 12550

DATE RECEIVED: Jul-18-2022
REPORT DATE: Jul-21-2022
CONDITION OF SAMPLE: Normal

PARTICLE SIZE (ASTM F1632)

		Gravel %				Soil Separate* %			Sieve Size / Sand Fraction Sand Particle Diameter % Retained				
Lab ID#	**Sample Name**	**3/4" 19 mm**	**1/4" 6.3 mm**	**No. 5 4.0 mm**	**No. 10 2.0 mm**	**Sand**	**Silt**	**Clay**	**No. 18 V. Coarse 1.0 mm**	**No. 35 Coarse 0.50 mm**	**No. 60 Medium 0.25 mm**	**No. 140 Fine 0.10 mm**	**No. 270 V. Fine 0.05 mm**
48073-1	TS-1	13.1	18.0	10.8	12.8	36.5	40.3	23.2	10.7	7.0	5.9	6.5	6.7
48073-2	TS-2	0.0	13.3	5.9	5.2	36.7	40.5	22.9	8.0	7.8	7.0	7.3	6.9
48073-3	TS-3	0.0	4.4	2.2	6.3	46.2	35.9	17.9	8.5	9.7	9.5	10.0	8.5
48073-4	TS-4	0.0	10.7	4.5	11.1	54.2	30.1	15.7	13.9	13.4	12.0	6.7	8.1
48073-5	TS-5	0.0	4.3	4.6	9.7	53.1	32.4	14.5	11.8	12.4	12.9	7.1	8.8
48073-6	TS-6	0.0	16.9	1.7	4.9	14.5	54.7	30.8	4.5	2.6	2.4	2.9	2.1

Lab ID#	**Sample Name**		**Ksat** in/hr**	**Bulk Density** g/cc**				**pH[1] 1:1**	**% Organic Matter[2] Dry Weight**	**Textural Class**
48073-1	TS-1		0.3	1.49				5.4	3.21	Very Gravelly Loam
48073-2	TS-2		0.9	1.43				4.7	4.27	Gravelly Loam
48073-3	TS-3		0.7	1.38				5.3	4.06	Loam
48073-4	TS-4		0.9	1.44				6.0	3.30	Gravelly Sandy Loam
48073-5	TS-5		0.5	1.45				5.8	3.37	Gravelly Sandy Loam
48073-6	TS-6		1.8	1.25				7.0	4.44	Gravelly Silty Clay Loam

*ASTM F1632 Method B

[1]ASTM D4972, method A, $CaCl_2$, 25 g sample used

[2] ASTM F1647 Method A

Data reported using USDA definitions of soil classification

** Saturated Hydraulic Conductivity (K-SAT) with compaction energy reduced to 5.75 ft lb/sq inch. Field infiltration rates may be lower, if soil is more heavily compacted than lab test conditions.

Samples were tested as received and comments pertain only to the samples shown.

Samples were received with a transmittal letter.

Reviewed by _____

35 King Street, Trumansburg NY 14886 Phone: 855-769-4231
E-mail: lab@turfdiag.com Website: http: www.turfdiag.com

Turf & Soil Diagnostics

July 21, 2022

Tectonic Engineering
Wallkill CSD – 11476.01
TSD File #48073

This report details the results of the TS-1, TS-2, TS-3, TS-4, TS-5, and TS-6 samples, which were tested as received. No specifications were provided with these samples.

The TS-1 sample is classified as very gravelly loam per the USDA textural classification scheme. There is approximately 55% gravel with a significant amount larger than ¾". The amount of gravel is not desirable for most sports field and turf applications.

The TS-2 sample is classified as gravelly loam. The TS-3 sample is classified as loam and is the only sample with less than 15% gravel.

The TS-4 and TS-5 samples are classified as gravelly sandy loam. These two samples have the highest sand content.

Sandy loam and loam soils typically have potential to provide acceptable water and nutrient holding for most turf and landscapes. They provide limited internal drainage and can be prone to excess compaction under heavy use.

The TS-6 sample is classified as gravelly silty clay loam. This sample has the lowest sand content and also has significant amount of gravel larger than ¼". Silty clay loams such as this are very fine textured soils that tend to have high water retention. These types of soils are also prone to compaction and are typically not well suited for high traffic areas in high quality turf and landscape installations. They may be more suitable for low traffic areas.

The infiltration rates of these samples are all low and suggest limited internal drainage should be expected. The infiltration rates are related to bulk density, such that the soils may have higher infiltration rates if installed and maintained at lower bulk densities. As indicated by the low infiltration rates, fields should be crowned to ensure adequate surface drainage.

An organic matter content of 3 to 5% by weight is typically recommended for most turf soils of this type. The samples have organic contents within this range.

The following are options to consider if there is a desire to improve the internal drainage and reduce the risk of compaction and excessive water retention:

- aggressive topdressing and aerification program to slowly build up a sandy layer at the surface of the field,
- building a sand cap instead of incorporating the sand into the soil, or
- building slit drains through the field.

35 King Street, Trumansburg, NY 14886
Phone: 855-769-4231 Email: lab@turfdiag.com Web: www.turfdiag.com

The soils likely need screening prior to use to remove some of the gravel. As with any soil installation, it will be especially important to control compaction during the placement and grading of the soil. The soil shouldn't be handled when wet. Equipment with low ground pressure is recommended for the placement and gradation of the soil.

Please let us know if you have any questions or are in need of further assistance. Samples are generally kept on the premises for 45 days after report date. Thank you for using Turf & Soil Diagnostics, Inc.

Duane K. Otto
Vice President

Turf & Soil Diagnostics, Inc.
35 King Street, Trumansburg, NY 14886
Phone: 855-769-4231 Email: lab@turfdiag.com Web: www.turfdiag.com

Our Story

For the past 30 years, Tectonic has delivered quality professional services in a timely and cost effective manner by pooling its talented staff into project teams that think, act, and perform as one integral unit. By carefully listening and collaborating with its clients, the firm is able to identify the key issues and assure stakeholder objectives are met in the final deliverables. Through innovating and adopting technological advances, the firm is able to generate unique solutions to improve our nation's deteriorating infrastructure and build safe sustainable communities.

As the world evolves, and its challenges grow more complex, Tectonic continues to innovate and provide the practical solutions and exceptional customer service its clients have trusted since its founding.

www.TectonicEngineering.com

Tectonic

MOUNTAINVILLE, NY (CORPORATE OFFICE)
70 Pleasant Hill Road, PO Box 37
Mountainville, NY, 10953
Phone: 845-534-5959
Fax: 845-534-59993

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes construction dewatering.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.3 ALLOWANCES

A. Dewatering observation wells are part of dewatering allowance.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.5 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.

2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

C. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

1.8 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
2. The geotechnical report maps and boring logs are included elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.

2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.

3. Prevent surface water from entering excavations by grading, dikes, or other means.

4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.

5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 015000 "Temporary Facilities and Controls," Section 311000 "Site Clearing," during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks monthly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.
B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19

SECTION 31 23 23.33 – FLOWABLE FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes flowable fill otherwise known as controlled low-strength material (CLSM) to be used for:

1. Structural Fill: For backfill under structures, pavements, concrete pads, etc; and for filling of void areas (i.e. tanks.)
2. Backfilling trenches and pits for buried utilities.

1.3 DEFINITIONS

A. Backfill: Flowable fill used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

C. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

D. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below aggregate base, structural fill, drainage fill, or topsoil materials.

E. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Certificates: Submit written certifications for cement and fly ash complying with requirements of ASTM standards specified in Part 2 - Products.

B. Design Mixtures: For each flowable fill mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

2. Test Reports: Submit test reports for strength test, consistency and unit weight tests, and aggregate gradation specified in Part 2 - Products.

a. Strength Test: Include minimum of 10 compressive strength test results.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 to perform material evaluation tests and to design flowable fill mixtures.

1. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 229R, "Controlled Low-Strength Materials," Sections 1 through 7.

PART 2 - PRODUCTS

2.1 FLOWABLE FILL MATERIAL

A. Self-compacting, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150, Type I or Type II.

2. Fly Ash: ASTM C 618, Class C or F (Contractor's option)

3. Normal-Weight Aggregate: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source and of a 3/8-inch nominal maximum aggregate size.

4. Air-Entraining Admixture: ASTM C 260 (Contractor's option.)

5. Water: ASTM C 94/C 94M.

B. Produce conventional-weight, flowable fill material with compressive strength when tested according to ASTM C 495 as indicated below.

1. Structural Fill: For backfill under structures, pavements, concrete pads, etc; and for filling of void areas (i.e. tanks.): 28-day compressive strength of 140 psi.
2. For backfilling trenches for utilities and pits for buried utility structures: 28-day compressive strength of 80 psi.

C. Prepare design mixtures for each type and strength of flowable fill, proportioned on the basis of trial mixture test data. Use a qualified independent testing agency for preparing and reporting proposed mixture designs.

D. Ready-Mixed Flowable Fill: Measure, batch, mix, and deliver flowable fill according to ACI 304R, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ground Surface Preparation: Remove vegetation, debris, unsuitable soil materials, obstructions and deleterious materials from ground surface prior to placement of flowable fill. Ensure ground surface is free from mud, frost, snow and ice.

B. Place flowable fill backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Testing and inspecting underground utilities.
3. Removing concrete formwork.
4. Removing trash and debris.
5. Removing temporary shoring and bracing, and sheeting.
6. Installing permanent or temporary horizontal bracing on horizontally supported walls.

C. Preparation of tanks to be filled with flowable fill: Empty tanks of all contents prior to placement of flowable fill.

D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PLACEMENT

A. Placement Around Objects Subject to Floating (pipes, tanks, pools, etc.): Provide measures such as straps, soil anchors or similar approved methods to prevent flotation or misalignment. Where applicable, place material in lifts to prevent flotation and loading of object due to wet weight of flowable fill above. Allow each lift to harden before continuing with placement.

B. Placement Over Pipes or Other Objects: Provide measures such as placing material in lifts and allowing each lift to harden between pours to prevent overloading of object due to wet weight of flowable fill above.

C. Utility Trench Backfill:

1. Place initial backfill of flowable fill to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.
2. Place final backfill of flowable fill to final subgrade elevation.

D. Placement Adjacent to Formwork, Embankments, or Other Site Containment Structures: Provide measures such as placing material in lifts and allowing each lift to harden between pours. Design all formwork or other flowable fill containment structures to resist lateral load imposed by placement of flowable fill.

E. Placement Adjacent to Foundation Walls, Retaining Walls, Basement Walls, and Similar Items: Brace walls as required to resist lateral loads imposed by placement of flowable fill or place material in maximum 2-ft. high lifts, allowing each lift to harden between pours. Where possible, bring flowable fill up evenly on both sides of walls.

F. At basement walls, refer to Drawings for notes requiring placement of basement slab and first floor slab prior to backfilling of wall.

G. Allow minimum 24 hours after placement of flowable fill before beginning construction installed over flowable fill. Protect flowable fill from freezing for minimum 24 hours after placement.

H. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain flowable fill temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool flowable fill is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing flowable fill. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspection agency to perform tests and inspections and prepare test reports.

B. Inspections

1. Verification of use of required design mixture.
2. Flowable fill placement, including conveying and depositing.

C. Tests

1. Compressive Strength Testing:

a. Specimen Preparation: Comply with ASTM D 4832 requirements to prepare 1 set of standard cylinders (minimum 4 ea.) for each compressive strength test.

b. Comply with ASTM D 4832 requirements for testing of 1 set of specimens for each 100 cubic yards (or fraction thereof) of each type of flowable fill placed in each day as follows:

1) Test 3 specimens at 28 days after flowable fill placement.
2) Retain 1 specimen for later testing, if required.

2. Unit Weight Testing: Perform in accordance with ASTM D 6023.

3. Consistency Testing: Perform in accordance with ASTM D 6103.

END OF SECTION 31 23 23.33

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS (SPDES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Erosion, sediment and pollution controls as shown on the Drawings and as directed by the Engineer (qualified professional) to significantly reduce runoff on downstream properties. This includes temporary control measures to mitigate land disruption by other contractors during construction of this project.

    a. Qualified Professional: Is a licensed professional engineer, a registered landscape architect, or a certified professional in erosion and sediment control.

2. Erosion, sediment and pollution control includes, but is not limited to, the following:

    a. Standard control measures such as storm structure protection, silt fence, silt fence dikes, and rip rap.
    b. Off site sediment tracking controls.
    c. Sedimentation basin.
    d. Seeding, sodding and erosion control fabric.
    e. Rock check dam, sediment trap and detention basin with weir.
    f. Temporary protection for existing vegetation.
    g. Clean up.

3. Comply with the Stormwater Pollution Prevention Plan (SWPPP) for this Project in consultation with appropriate local agencies and soil conservation service. *Any local or State Agency requirements are considered part of these specifications.*

B. Related Sections

1. Section 31 10 00 – Site Clearing
2. Section 31 20 00 – Earth Moving
3. Section 32 12 16 – Asphalt Paving
4. Section 32 92 00 – Turf and Grasses
5. Section 33 41 00 – Storm Utility Drainage Piping

1.3 CODE COMPLIANCE

A. The New York State Department of Environmental Conservation (NYSDEC) requires a SPDES General Permit for Storm Water Discharges from Construction Activity that disturbs one (1) acre of land or more. This Permit GP-0-20-001 is pursuant to the Environmental Conservation Law and has penalties and fines related to violations.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product listed.

1. Filter fabric and hardware cloth for storm structure protection.
2. Silt fence and silt fence dikes.
3. Straw bales.
4. Stakes.
5. Erosion control blanket.
6. Turf reinforcement matting.
7. Bonded fiber matrix.
8. Soil stabilization fabric for off-site sediment tracking control.
9. Channel drain inlet filter matting
10. Drop-In Inlet Protection.

B. Material Certificates: Materials certificates showing content/mechanical analysis are required for the following products. Also, provide samples as noted.

1. Granular Backfill: Sample.
2. Granular Base Course Material: Sample.
3. Seeding & Sodding.
4. Rip Rap.
5. No. 4 stone for off-site sediment tracking control.
6. 4,000 psi concrete.

1.6 INFORMATIONAL SUBMITTALS

A. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Contractor and manufacturer (where applicable) indicating compliance with applicable “Qualifications” requirements specified below in “Quality Assurance” article.

2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

B. Certification Statement: Submit photocopy of Certification Statement filled out completely and accurately to the Architect. Construction activities shall not begin prior to submitting certification statement. *Certification Statement Form attached to the end of this Section*.

C. Trained Contractor Qualifications: Submit documents identifying the designated Trained Contractor (required by SPDES Permit) and proof of their successful completion of a NYSDEC endorsed 4 hr Training Course within the last three (3) years.

1.7 QUALITY ASSURANCE

A. Perform erosion, sediment and pollution control in compliance with the Contract Documents and applicable requirements of the New York Standards and Specifications Erosion and Sediment Control and other governing authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handle and store products according to manufacturer's written instructions.

1.9 NOTICES

A. The Owner will file with the NYSDEC a Notice of Intent (NOI) a minimum of five (5) days prior to start of construction. Unless notified by the NYSDEC to the contrary within five (5) days, a General SPDES Construction Permit is automatically issued which authorizes discharge of storm water on the construction site.

B. Pre-Construction Conference: Within seven days of start of construction, attend Civil/Structural Preconstruction Meeting. Representatives of all Contractors responsible for earthwork operations are required to attend.

C. Each Contractor responsible for soil disturbances shall identify at least one person from their company that will be responsible for implementation of the SWPPP. This person shall be known as the *Trained Contractor.* Each Contractor shall ensure that at least one *Trained Contractor* is on site on a daily basis when soil disturbance activities are being performed.

D. When the site has been finally stabilized, Contractor shall notify the Architect, in writing, that a final inspection be performed. Upon satisfactory completion of this inspection, the Owner will file with the NYSDEC a Notice of Termination (N.O.T.).

E. The Owner is responsible for payment of annual fees related to the SPDES permit. Filing of a NOT shall typically terminate the Owner's fee responsibility.

F. Pay any fines issued by any agency as a result of non-compliance with the SWPPP or SESC Plans.

G. Duty to Comply: The Owner must comply with all conditions of the SPDES General Permit. All contractors and subcontractors associated with the Project must comply with the terms of the SWPPP. Any non-compliance with the permit constitutes a violation of the Clean Water Act (CWA) and the Environmental Conservation Law (ECL) and is grounds for enforcement action against the Owner and/or the contractor/subcontractor; permit revocation, suspension or modification; or denial of a permit renewal application. Upon a finding of significant non-compliance with the permit or the applicable SWPPP, the DEC may order an immediate stop work to all construction activity at the site until the non-compliance is remedied.

1.10 INSPECTIONS AND MAINTENANCE

A. When construction activities are on-going, the Licensed Professional Engineer, Registered Landscape Architect, Certified Professional in Erosion and Sediment Control, or qualified personnel of the Owner shall review disturbed areas of the construction site at least once every seven (7) calendar days. For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and temporary stabilization measures have been applied to all disturbed areas, the qualified inspector shall conduct a site inspection at least once every thirty (30) calendar days. Reviews shall include, but not be limited to discussion of schedule, observation of areas not finally stabilized, effectiveness of control measures, corrective measures and violations. Special attention will be focused on areas not finally stabilized, structural control measures, and locations where vehicles enter or exit the site. Disturbed areas will be inspected for pollutants entering the drainage system. Structural control measures will be reviewed for effectiveness in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the site will be inspected for evidence of off site sediment tracking. A written report of construction reviews shall be produced during construction operations.

B. Provide timely maintenance of vegetation erosion and sediment control measures, and other protective measures, during construction. Keep a written record of maintenance and corrective work in a journal. The journal shall be added to the on site SWPPP.

C. Maintain a field copy of the General Permit, NOI, NOI Acknowledgement Letter, SWPPP, inspection reports, and erosion control maintenance logs at the construction site until all disturbed areas have achieved final stabilization and the NOT has been submitted to the DEC. The documents must be maintained in a secure location, such as a job trailer, on-site construction office, or mailbox with lock. The secure location must be accessible during normal business hours to a representative of the Owner, Engineer, and NYSDEC.

D. Perform corrective measures within three (3) calendar days of the Engineer's or Owner's report at no cost to the Owner. Failure by the Contractor to perform corrective work within this schedule automatically authorizes the Owner to hire others and deduct from the Contract Sum the costs incurred by the Owner for the performance of this Work.

E. The Owner shall provide long term maintenance of the storm water facilities after Notice of Termination has been issued. The designated maintenance personnel shall keep written records of maintenance and corrective work in a journal. The journal shall be added to the on site SWPPP.

F. *The Owner* shall retain a copy of the NOI, NOI Acknowledgment Letter, SWPPP, MS4 SWPPP Acceptance Form, NOT, and any inspection reports that were prepared in conjunction with this permit for a period of at least five (5) years from the date that the site achieves final stabilization.

PART 2 - PRODUCTS

2.1 STORM SEWER PROTECTION

A. 1/2-inch mesh hardware cloth covered with a polypropylene silt fence fabric.

2.2 STRAW BALES

A. Clean, free of dirt, hay, grass, or weeds.
B. Bound with twine or wire.
C. Bales, when placed, shall be dry and capable of passing water.

2.3 SILT FENCE

A. Meet the following criteria unless specific type is shown on plans or Architect accepts the change in criteria.

1. Silt Fence: Polypropylene filter fabric supported by non-pressure treated hardwood posts meeting the following requirements.

Property	Unit	Test Method	Value
Grab Tensile Strength (Machine Direction)	lbs	ASTM D 4632	124 min
Grab Tensile Strength (Cross-Machine Direction)	lbs	ASTM D 4632	124 min
Grab Tensile Elongation	%	ASTM D 4632	15 / 15
Trapezoid Tear Strength	lbs	ASTM D 4533	65 min
Mullen Burst Strength	psi	ASTM D 3786	300 min
Puncture Strength	lbs	ASTM D 4833	60
Ultraviolet Stability (Strength Retained)	%	ASTM D 4355	70
Apparent Opening Size (AOS)	U.S. Sieve	ASTM D 4751	30
Permittivity	sec^{1}	ASTM D 4491	0.10
Coeff of Permeability	CM/Sec	ASTM D 4491	0.005 min
Water Flow Rate	$gal/min/ft^2$	ASTM D 4491	25 min

2. Basis of Design Product: Subject to compliance with requirements provide Tencate Geosynthetics Mirafi 100X fabric or comparable product.

3. Reinforced fence: Fabric backed with 14-1/2 gauge by 6-inch square mesh woven wire. See plans and details for specific locations or requirements.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. DGI Industries.
2. Hanes Geo Components.
3. TenCate Geosynthetics (Mirafi).

2.4 STAKES

A. One of the following:

1. 2-inch by 2-inch nominal by 4-feet long, non-pressure treated hardwood.
2. #4 rebar, 4-feet long min.

B. Maximum post spacing permitted shall be: 8-ft 4-in O.C.

2.5 STONE FILTERS

A. Size shown on the plans meeting the requirements of ASTM C33 or State specifications where applicable.

2.6 PERMANENT SEEDING AND SODDING

A. Refer to applicable section.

2.7 TEMPORARY SEEDING (unless otherwise shown on Drawings):

A. Minimum requirements:

1. Lime: 1/2 ton per acre.
2. Fertilizer: Commercial 5-10-10 or equivalent (600 lbs per acre).
3. Seed: Ryegrass (annual or perennial) (40 lbs. per acre).
4. Mulch: Straw at 2 ton per acre.

2.8 EROSION CONTROL BLANKETS

A. On Slopes 3:1 and Flatter – Netless Biodegradable Blanket: 100% biodegradable stitched excelsior erosion control matting. (Netted erosion control fabric on slopes 3:1 and flatter is not allowed.)

1. Material Characteristics:

a. Soil loss ratio: .063
b. Fiber Size: 80% of fibers min. of 6 inches long
c. Weight: 0.73 lb per square yard.

d. Channel Flows: Suitable for channel flows up to 3.0 ft./second and 1.0 lb/ft. shear stress.

2. Staples: Use manufacturer provided staples.

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. "Curlex NetFree" Erosion Control Blanket manufactured by North American Green.

B. On Slopes Steeper than 3:1 up to 1.5:1 – 100% biodegradable excelsior erosion control matting with polypropylene netting containing a UV degrader additive.

1. Material Characteristics:

a.	Fiber Count:	7,000 per square yard.
b.	Fiber length:	80% of fibers min. of 6" long
c.	Net Openings:	1.0 inch x 2 inches
d.	Thickness:	0.411 inch per ASTM D 6525
e.	Swell:	49% per ECTC Procedure
f.	MD-Tensile Strength Max.:	74.4 lb./ft. per ASTM D 6818
g.	TD-Tensile Strength Max.:	36.0 lb./ft. per ASTM D 6818

2. Staples: Use manufacturer provided staples.

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. "Curlex I QuickMow" Erosion Control Blanket manufactured by North American Green.

2.9 TURF REINFORCEMENT MATTING

A. Permanent erosion control/turf reinforcement mat constructed of a matrix of polypropylene monofilament yarns woven into uniform configuration of resilient pyramid-like projections.

1. Material Properties:

Property	Test Method	Units	Property Requirement
Thickness	ASTM D-6525	mm (in)	10.2 (0.40)
Resiliency	ASTM D-6524	percent	80
Mass Per Unit Area	ASTM D-6566	G/sq m (oz/sy)	455 (13.5)
Tensile Strength	ASTM D-6818	kN/m (lbs/ft)	58.4 x 43.8 (4,000 x 3,000)

Tensile Elongation	ASTM D-6818	percent	65 (max)
Light Penetration (% Passing)	ASTM D-6567	percent	10
UV Resistance	ASTM D-4355	percent	90 at 6000 hrs

2. Performance Properties: In a vegetated state, the RECP must demonstrate acceptable performance (as defined by the Engineer) when subjected to at least 0.5 hrs of continuous flow producing the following conditions:

    a. Permissible velocity: 7.6 m/sec (25 ft/sec)
    b. Permissible tractive force (shear stress): 0.718 kPa (15 psf)

3. Color: Green.

4. Basis of Design Product: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Pyramat Geotextile System by Propex, Inc.

2.10 BONDED FIBER MATRIX

A. Hydraulically applied continuous layer of biodegradable elongated fiber strands held together by a water-resistant bonding agent with no holes greater than one millimeter in size.

B. Physical Components:

1. Ingredients/Composition:

    a. Gypsum-based, soil beneficial binder
    b. Cellulosic fiber mulch (paper/soft wood)
    c. Plant-based tackifiers (short-term binding agents)
    d. Nonpetroleum-based polymers (long-term binding agents)
    e. Surfactant
    f. Water-holding polyacrylmides (PAM)

C. Physical Properties:

1. Moisture: 10% (+/- 2%)
2. pH: 5.5 – 6.5
3. Mix: 70lbs (+/-10 lbs.) per 100 gallons of water (Recommended)
4. Color: Green
5. Wood/Cellulose Fiber: 70% / 30%
6. Water Holding ASTM D 7367-07: 850-950%
7. Water Holding ASTM Modified Method: 1200 – 1400%

D. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. "Enviro-Shield" Brand Bonded Fiber Matrix by USG.
2. "Flexterra" by Profile Products, LLC.

2.11 STABILIZED CONSTRUCTION ENTRANCE

A. No. 4 stone meeting the following requirements:

Standard ASTM Sieve Size	Percent Passing by Weight
4 inch	100
3 inch	90-100
2 inch	0-15
Passing No. 50	5-10
Passing No. 100	2-5

B. Soil Stabilization Fabric:

1. Stabilization Fabric: A commercially manufactured, UV stabilized low clogging, high flow, woven geotextile meeting the following requirements.

Property	Unit	Test Method	Value
Grab Strength	lbs	ASTMD-4632	315 min
Tensile Strength	lbs/in	ASTMD-4595	175 min
Grab Elongation	%	ASTMD-4632	15 max
Trapezoid Tear	lbs	ASTMD-4533	120 min
Mullen Burst	psi	ASTMD-3786	600 min
Permittivity	/Sec	ASTMD-4491	.05min
Water Flow Rate	gal/min/ft^2	ASTMD-4491	4 min

2. Basis of Design Product: Subject to compliance with requirements, provide TenCate Geosynthetics, Mirafi 600X fabric or comparable product.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. DGI Industries.
   b. Hanes Geo Components.
   c. TenCate Geosynthetics (Mirafi).

C. Granular Base Course Material: Shall be as specified in Earth Moving Section.

2.12 TEMPORARY TREE PROTECTION

A. Stakes: 2 inch by 4 inch x 6 foot (min) non-pressure treated hardwood.

B. Top Rail: 2 inch by 4 inch x 8 foot (max) non-pressure treated hardwood fastened to stakes by nails or screws.

C. Fabric:

1. Heavy duty orange construction barrier fencing.
2. Basis of Design Product: Subject to compliance with requirements, provide Tenax Corporation “Sentry HD” fencing or comparable product.
3. Fabric shall be attached to the stakes and top rails with staples or other fasteners.

2.13 OUTLET SEDIMENTATION TRAP

A. Outlet Sedimentation Trap: Constructed of 12 inch pipe, AASHTO M294-Type S or SP corrugated HDPE N-12 pipe and stone as shown in the Drawings. Filter fabric shall be as specified for siltation fence. Hardware cloth shall be ½ inch mesh. Concrete shall be 4,000 psi.

2.14 CONCRETE WASHOUT

A. Provide concrete washout as specified.

2.15 ROCK CHECK DAMS AND SEDIMENT TRAPS

A. Provide stone rip rap as specified. Vegetation shall be as described on the Drawings.

2.16 CHANNEL DRAIN INLET FILTER MATTING:

A. Latex bonded coir (coconut) fiber matting, 4.0 Ounces per Square-Foot, 1-1/2” thickness.

B. Basis-of-Design product and standard of quality for channel drain inlet filter matting for use in existing and proposed channel drains shall be Natural Fiber Inlet Filter Matting, Item #IF1527X75FTB, by Blocksom & Co., Michigan City, Indiana. Telephone: 800-745-1408. Web: www.blocksom.com

C. Physical Properties: (4-inch wide strip specimen)

1. Fiber Material

   a. Latex bonded coir (coconut) fiber matting
   b. Nominal 4.0 ounces / square-foot, 1½” thickness.

2. Sediment Control per ASTM D 5141

   a. Test Material: Sand sieved through No. 10 sieve

b. Efficiency: 59.1%
c. Minimum flow rate: 150 liters/minute

3. Tensile Properties per ASTM D 5035/ECTC

a. MD – Maximum Load: 14.6 ppi
b. TD – Maximum Load: 18.7 ppi
c. MD – Elongation at Max Load: 19.3%
d. TD – Elongation at Max Load: 27.7%

4. UV Resistance per ASTM D 4355 – 500 hr exposure

a. MD – Maximum Load: 10.2 ppi
b. TD – Maximum Load: 13.8 ppi
c. MD – Elongation at Max Load: 16.9%
d. TD – Elongation at Max Load: 16.6%

5. Smolder Resistance (ECTC)

a. Maximum Burn Distance: 0.29 in

6. Light Penetration (ECTC Guidelines)

a. Baseline Reading: 125
b. Reading with Sample: 10
c. Percentage Light Penetration: < 8%

7. Resiliency per ASTM D 6524

a. Pre-Loading Thickness: 1943 mils
b. Post-Loading Thickness: 326 mils
c. Percentage Change: -83%

8. Swell (ECTC)

a. Dry Thickness: 1984 mils
b. Thickness after Soak: 2098 mils
c. Percentage Change: 6%

9. Water Absorption per ASTM D 1117/ECTC

a. Pre-Soak Weight: 69 grams
b. Post-Soak Weight: 152 grams
c. Weight Change: 82 grams
d. Percentage Weight Change: 119%

10. Mass/Unit Area per ASTM D 6565

a. Mass/unit area: 50.89 oz/sq yd
b. Mass/unit area: 1725 g/sq meter

11. Filter Mat Filter Cable Ties

a. Heavy duty "zip" cable ties provided by filter manufacturer and designed specifically for inlet filter product, and in quantity required for manufacturer recommended installation method.

2.17 DROP-IN INLET PROTECTION:

A. Standard of quality for aftermarket inlet protection for use in existing and proposed catch basin, drop inlets, curb box inlets and storm manholes shall be Flexstorm Inlet Filters, by Inlet and Pipe Protection, Inc., Naperville, Illinois.

1. Description of System:

a. An aftermarket drop-in inlet filter system designed to collect silt and sediment from surface storm water runoff at drainage locations shown on the plans, at existing inlets in pavement where adjacent disturbance will allow sediment runoff to occur, in areas where access to the site dictates their use due to phasing issues, or as directed by the Engineer.

b. An aftermarket drop-in inlet filter system comprised of a corrosion resistant steel frame and a replaceable geotextile sediment bag attached to the frame with a stainless steel locking band. The sediment bag hangs suspended from the rigid frame at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment.

c. The aftermarket drop-in inlet filter frame includes lifting handles in addition to the standard overflow feature. A proprietary Removal Tool engages the lifting bars or handles to allow manual removal of the assembly without machine assistance. The frame suspension system is adjustable in ½" increments up to 5" per side on rectangular designs should the casting or drainage structure have imperfections.

d. Standard woven polypropylene sediment bags with a typical flow rate of 200 gpm / sq ft.

2. Woven Sediment Bag Material Specifications:

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
Mechanical			
Tensile Strength (Grab)	ASTM D-4632	255 x 275 lbs	1130 x 1220 N
Elongation	ASTM D-4632	20 x 15 %	20 x 15 %
Puncture	ASTM D-4833	135 lbs	600 N
Mullen Burst	ASTM D-3786	420 psi	2890 kPa
Trapezoidal Tear	ASTM D-4533	40 x 50 lbs	175 x 220 N
Endurance			
UV Resistance	ASTM D-4355	90%	90%
Hydraulic			
Apparent Opening Size (AOS)[3]	ASTM D-4751	20 US Std. Sieve	0.850 mm
Percent Open Area (POA)	CW-02215 Mod.[4]	20%	20%
Permittivity	ASTM D-4491	1.50 sec^{-1}	1.50 sec^{-1}
Water Flow Rate	ASTM D-4491	200 gpm/ft^2	8,145 $l/min/m^2$

3. Tested Filtration Efficiency:

   a. All testing performed in general accordance with the ASTM D 7351, *Standard Test Method For Determination of Sediment Retention Device Effectiveness in Sheet Flow Application*, with flow diverted into an area inlet. Test Soil used as sediment had the following characteristics with a nominal 7% sediment to water concentration mix:

Soil Characteristics	Test Method	Value
% Gravel	ASTM D 422	2
% Sand		60
% Silt		24
% Clay		14
Liquid Limit, %	ASTM D 4318	34
Plasticity Index, %		9
Soil Classification	USDA	Sandy Loam
Soil Classification	USCS	Silty Sand (SM)

Tested Efficiencies:

Property	Woven Sediment Bag
Filtration Efficiency	82%

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which soil erosion and sediment control is to be installed notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Beginning installation constitutes Contractor's acceptance of conditions.

3.2 SIGNATURE REQUIREMENTS

A. Between the Pre-Construction Meeting and starting site work:

1. Sign the certification statements. Prominently display the statements at the job site.

2. Review inspection and maintenance procedures. Decide where SWPPP will be temporarily stored for review by NYSDEC, Owner and Architect.

3. Designate specific Owner and Contractor personnel responsible for inspection and maintenance.

4. Prior to the start of construction, submit schedule for completion of installation of measures identified in SESC Plan and SWPPP. DO NOT BEGIN EARTHWORK OPERATIONS AT SITE UNTIL MEASURES IDENTIFIED IN SESC PLAN AND SWPPP HAVE BEEN ACCEPTED BY ARCHITECT AND INSTALLED AT SITE.

5. When conditions change during construction, submit revisions to the SWPPP to Owner, the Architect and other agencies identified in the SPDES permit and the SWPPP.

3.3 GENERAL EROSION CONTROL

A. Provide initial construction erosion control features, shown in the SWPPP and as indicated on Drawings and Specifications or as directed by the Architect, prior to disturbing the site with such construction operations as clearing and grubbing, topsoil stripping, earthwork, trenching excavation and removal of existing vegetation. Keep the disturbance to a minimum. Install other features as described in the sequence of erosion, sediment and pollution control on the drawings.

B. Minimize amount of bare soil exposed at one time. Do not disturb five (5) or more acres at one time. Disturbance of five (5) acres or more at one time requires the Contractor to obtain prior written permission from the NYSDEC to vary from the requirement of SPDES Permit GP-0-15-002. Provide written copy of approval from NYSDEC to the Owner and the Architect. Start permanent seeding within seven (7) calendar days of rough grading. When this is not possible, provide temporary seeding of perennial rye grass at the rate of three pounds seed per one thousand square feet. Provide temporary seeding within seven (7) days on non-roof, non-paved areas. When adverse weather conditions prevent good germination, repeat seeding as directed by the Architect until the area is stabilized. Till under temporary grass and fine grade when preparing for final seeding.

C. Until a disturbed area is stabilized, trap runoff sediment by the use of debris basins, sediment basins, silt traps, or other methods acceptable to the Engineer and governing authorities. Construct sediment basins to dimensions shown on plans.

D. Place sediment structures and or devices in accordance with dimensions shown on Drawings. If sediment structures and or devices become plugged or partially plugged, remove and replace. Cleaning of the sediment structures and or devices will only be allowed when method is reviewed by Engineer or Owner Representative and found acceptable.

E. Provide erosion controls on slopes and swales traversing, bordering, or leaving the site. Limit the water flow to a non-erosive velocity.

F. Do not store fill materials within fifty feet of the banks of any streams or water bodies, intermittent or perennial.

G. Provide temporary protection for trees and shrubs as outlined and shown on drawings and described in this Section.

H. Inspect erosion and sediment control measures immediately after each rainfall and at least daily during prolonged rainfall. Make required repairs immediately.

I. Remove sediment deposits before they reach one-half of the height of the total height of the installed sediment structure or device. Dispose sediment in a manner that does not result in additional erosion or pollution.

J. Provide prompt removal and disposal of rubbish and debris in accordance with the governing authorities.

K. Provide temporary grading of drainage channels, slopes, or fills in accordance with Section 31 20 00 “Earth Moving”.

L. Coordinate temporary erosion and sediment control measures with permanent erosion control features specified elsewhere in the Contract Documents to the maximum extent possible to assure economical, effective, and continuous erosion, sediment and pollution control.

M. Provide temporary and permanent dust controls on driving areas such as roads, bus loops, parking lots, haul roads and access points, as well as non-driving areas such as lawns and athletic fields and any other disturbed areas where damage, health hazards or traffic safety problems may occur if dust is not controlled.

N. Temporary measures are to be removed on upon final stabilization, prior to the issuance of the Notice of Termination.

3.4 MUNICIPAL SEWER AND WETLAND EROSION CONTROL

A. Control erosion, siltation and pollution to municipal sewers, water bodies and wetlands by taking appropriate measures such as, but not limited to, the following:

1. Prevent petroleum products and excessive amounts of silt, clay, and muck from entering municipal sewers, waters or wetlands of New York State during construction.

2. Prevent fresh concrete, concrete leachate and washings from equipment and trucks, from entering municipal sewers, waters or wetlands of New York State during construction.

3. Place silt fence to control erosion at the down slope edge of disturbed areas. Place this barrier to sediments before disturbance of the ground occurs and maintain in good condition until disturbed land is heavily vegetated or otherwise permanently stabilized.

4. Seed areas of soil disturbance resulting from this Project with appropriate perennial grass seed and mulched with straw within seven calendar days as described in general erosion control. Maintain mulch until a suitable vegetative ground cover is established.

3.5 STORM STRUCTURE PROTECTION

A. As shown on the Stormwater Pollution Prevention Plan (SWPPP) and the Soil Erosion and Sediment Control Plans (SESC), provide storm structure protection at each inlet as shown on the detail plan. Clean storm structure protection material after each storm event to permit the fabric and/or drainage stone to work effectively. Remove the drainage material when the site is stabilized and certified by the Architect and/or qualified personnel of the Owner.

3.6 SILT FENCE/STRAW BALE DIKES

A. Locate in accordance with plans and details and as directed by the Architect. Excavate trench along the lower perimeter(s) of site, along the contract limit line, and as indicated on the Drawings. The placement of silt fence and/or bales shall consider drainage paths and intercept drainage prior to leaving site or entering storm system. Place excavated material on uphill side of trench for backfilling.

B. Drive stakes securely into the downhill side of the trench. When prefabricated silt fence with fabric attached to stakes is used, drive stakes so that fabric is buried in the ground as detailed.

C. Backfill trench with excavated material, so that fabric is securely buried in the ground to prevent undermining. Tamp soil.

D. Join sections by overlapping fabric between two stakes. Set stakes simultaneously. Overlap by minimum six inches, fold, and staple to prevent sediment bypass.

E. Attach silt fence securely to stakes spaced no more than eight feet on center. Secure fence fabric to stake with minimum three one inch staples.

F. Provide silt fence dikes perpendicular to swale center lines in swales one and one half percent and steeper. Locate dikes at a maximum interval of fifty feet on center unless otherwise shown on drawings.

G. Removal of silt and replacement of silt fence and/or bales shall be on going throughout the duration of the project to maintain an effective silt removing barrier.

3.7 TEMPORARY SEEDING

A. When necessary, provide temporary seeding as described in this Section.

B. Seedbed Preparation:

1. Scarify soil if compacted.
2. Remove debris and obstacles such as rocks and stumps.
3. Apply lime and fertilizer.
4. Apply seed uniformly by mechanical seeder or hydroseeder.
5. Apply straw mulch.

C. Provide permanent seeding as described elsewhere in the Contract Documents.

3.8 EROSION CONTROL MAT

A. Install where indicated on Drawings. Install in accordance with manufacturers' recommendations and design details, including number and location of staples.

3.9 TURF REINFORCMENT MATTING

A. Install where indicated on Drawings. Install in accordance with manufacturers' recommendations and design details, including number and location of staples.

3.10 BONDED FIBER MATRIX

A. Hydraulically install bonded fiber matrix in strict accordance with manufacturer's installation instructions at the maximum rate given.

B. Typical Application Rates:

1. <3:1 Slope: 3,000 lbs./acre
2. 3:1 < 2:1 Slope: 3,500 lbs./acre
3. >2:1 Slope: 4,000 lbs./acre

C. Limitations: Do not use this product in the following conditions. Notify Architect if these conditions exist.

1. Concentrated overland water flow.
2. On soils that display deep-seated instabilities.
3. Where soil compaction problems exist or on soils that are subjected to frost heave and/or surface peeling (loosening of top layer of soil).

D. Store and handle material per manufacturer's requirements.

3.11 OFFSITE SEDIMENT TRACKING CONTROLS

A. Install as detailed and shown on Drawings to eliminate tracking sediment off site. Inspect after each rain storm and at least one time per week. When sediment begins tracking off site, immediately replace stone with clean No. 4 stone to retain sediment on site. Remove fabric and stone at project completion. Complete construction of proposed final surface(s).

B. Provide wash down areas stabilized with stone that drain into Engineer approved sediment trapping device. Do not flush into water bodies, wetlands, on site or municipal systems.

3.12 CONCRETE WASHOUT

A. Materials in or destined for the washout area shall not contact the ground, nor shall water or other liquid discharge from the containment structure.

B. Locate washout area a minimum of 50-ft from open channels, storm drain inlets, wetlands or water bodies.

C. Locate washout area so that it is accessible to concrete equipment (served with a minimum 10-ft wide gravel accessway).

D. Minimum dimensions:

1. For pre-fabricated units are 4-ft by 4-ft by 1-ft deep with a minimum 4-mil polyethylene plastic liner.

2. For constructed concrete washout areas are 6-ft by 6-ft by 3-ft deep, with a minimum 10-mil polyethylene liner, 2H:1V side slopes, and a 1-ft high by 1-ft wide compacted fill berm.

E. The liner must be free of tears or holes and placed over smooth surfaces to prevent puncturing. For excavated washouts, anchor the liner underneath the berm or overtop with sandbags or concrete blocks to hold in place.

F. Provide a sign designating the washout area, and for large construction sides, provide signs throughout directing traffic to its location.

G. Allow washed out concrete mixture to harden through evaporation of the wastewater. Once the facility has reached 75 percent of its capacity, remove the hardened concrete by disposing offsite.

H. Apply a new liner before reusing the station for additional washouts after maintenance has occurred.

3.13 OUTLET SEDIMENTATION TRAP

A. Install as detailed. Remove temporary trap and install permanent end section per detail near end of project when directed by the Architect.

3.14 ROCK CHECK DAMS AND SEDIMENT TRAPS

A. Install rip rap and vegetation as detailed on the Drawings and described elsewhere in the Contract Documents.

3.15 CHANNEL DRAIN INLET FILTER MATTING

A. Install channel drain inlet matting per manufacturer's installation requirements.

B. Cut matting if necessary to allow minimum 3" overlap at each side of the grate. Attach the mat to the topside of the inlet grate using cable ties.

C. Clean silt from around channel inlet matting following each rain event and as required by the Soil Erosion and Sediment Control plans and specifications, and as dictated by the Storm Water Pollution and Prevention Plan (SWPPP). Sweep the top of mat to clear built-up silt and solids, and dispose of. Do NOT allow accumulated sediment to enter the inlet.

3.16 DROP-IN INLET PROTECTION

A. Install channel drain / inlet drain filter matting per manufacturer's installation requirements.

B. Clean silt from filter bag following each rain event and as required by the Storm Water Pollution and Prevention Plan (SWPPP). Do NOT allow accumulated sediment to enter the inlet.

C. The Contractor cannot pierce, cut, remove inlet filter bag to allow discharge of turbid water to the drainage system.

3.17 TREE PROTECTION

A. Temporary Protection for Trees and Shrubs:

1. Provide temporary fencing, barricades or guards as required to protect trees and other plants, which are to remain, from above ground damage.

2. Protect root system from smothering. Do not store construction materials, debris, or excavated material within drip line (outer perimeter of branches). Do not permit vehicular traffic or parking within drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.

3. Should any trees or shrubs be damaged which are to be saved, arrange to have such damage treated by a licensed arborist or tree surgeon.

4. Trees or shrubs which die because of the Contractor's failure to conform to the Drawings and specifications shall be evaluated by a qualified organization selected by the Owner's Representative. The removal and replacement of the tree, and the evaluation expenses shall be paid for by the Contractor. Contractor shall be required to replace the damaged tree with plant material of comparable size and quality (i.e. damaged 12 inch caliper Red Maple shall be replaced by three 4 inch cal. or four 3 inch cal. Red Maples). Substitutions for variety shall be approved by the Architect

3.18 CLEANING

A. During the Contract and at intervals as directed by the Engineer and as erosion, sediment and pollution control procedures are completed, clear the site of extraneous materials, rubbish, and debris. Leave the site in a clean, safe, well draining, and neat condition.

B. Clean storm ponding areas, catch basins, detention basins, and other buried structures. Clean out contaminants, sediment, rubbish, construction debris, foreign objects and accumulated floatables from chambers and ponding areas thoroughly, immediately prior to final acceptance.

END OF SECTION 31 25 00

Attachment: Certification Statement

CERTIFICATION STATEMENT

Authorized, legally responsible signatures for the General Contractor, Site Earthwork, and Landscaping Subcontractor(s) shall sign and prominently display the following certification statement at the job trailer or office during the life of the project:

"I hereby certify under penalty of law that I understand and agree to comply with the terms and conditions of the Storm Water Pollution Prevention Plan (SWPPP) and agree to implement any corrective actions identified by the qualified inspector during a site inspection. I also understand that the operator (person, persons, or legal entity which owns or leases the property on which the construction activity occurs) must comply with the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") General Permit for storm water discharges from construction activities 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. "

1. General Contractor

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

2. Site Earthwork Contractor

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

3. Site Landscape Contractor

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

4. Other Prime Contractor(s) *(as determined by the Architect – Make* additional *copies as* n*ecessary)*

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
B. The principle reference for materials and methods is the "New York State Department of Transportation Standard Specifications for Construction and Materials," latest edition (NYSS).

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Pavement-marking paint.

B. Related Sections:

1. Section 31 20 00 "Earth Moving" for subgrade and aggregate base preparation and other requirements.

1.3 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

a. Job-Mix Designs: For each job mix proposed for the Work.
b. Paving Schedule
c. Paver / Asphalt installation showing joints.
d. Equipment to be used including, but not limited to paver(s) and roller(s).
e. Location of Mix Plant
f. Trucking operation including number of vehicles.

C. Qualification Data:

1. Manufacturer's Certificates: Certify that hot mix asphalt products meet or exceed NYSDOT Standard Specifications:

a. Section 401: Plant Production
b. Section 402: Hot Mix Asphalt (HMA) Pavements
c. Section 407: Tack Coat
d. Section 685: Pavement Markings

1.4 QUALITY ASSURANCE

A. Manufacturer and Mixing Plant Qualifications: A paving-mix manufacturer and mixing plant with NYSDOT approved materials and batch plant equipment complying with the following NYSDOT Standard Specifications:

1. Section 401: Plant Production
2. Section 402: Hot Mix Asphalt (HMA) Pavements.

B. Asphalt Paving Installer: Company specializing in performing work described in this section with minimum experience of three years.

C. Permits: Submit certified copies of all permits obtained from local regulatory agencies and New York State Department of Transportation.

D. Installation Requirements: Work to be performed in accordance with the following NYSDOT Standard Specifications:

1. Section 402: Hot Mix Asphalt (HMA) Pavements
2. Section 407: Tack Coat
3. Section 685: Epoxy Reflectorized Pavement Markings

E. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
2. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
3. Review condition of subgrade and preparatory work.
4. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
5. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.5 REGULATORY REQUIREMENTS

A. Obtain written permission and required permits from applicable agency prior to start of construction, and submit copies of permits as specified in “Submittals - Quality Control Submittals” above.

1.6 PROJECT CONDITIONS

A. Temperature and Seasonal Limitations: Refer to NYSDOT 402-3.01 Temperature and Seasonal Limitations.

1. Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, if the temperature has not been above 35 deg for 12 hours immediately prior to application or if the following minimum surface temperatures are not met.

2. Minimum Surface Temperatures: Comply with NYSDOT Standard Specifications Section 402, table 402-1 – Temperature Requirements.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature in accordance with NYSDOT Standard Specifications Section 685-3.02 – Atmospheric Conditions.

PART 2 - PRODUCTS

2.1 AGGREGATE SUBBASE AND BASE FOR ASPHALT PAVING

A. Refer to Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

2.2 ASPHALT PAVING MIX AGGREGATES

A. Aggregates for binder and top course: Conform to the requirements of NYSDOT Standard Specification 401-2.02, Aggregates.

2.3 ASPHALT MATERIALS

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes meeting NYSDOT Standard Specifications, Section 402 (70 Series) for each pavement course and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Mixes to be placed at thickness noted on the Drawings.
3. Binder Course (2-in < t < 3-in): NYSDOT No. 402.197904 (Type 3 Binder). Maximum 20% RAP permitted.
4. Binder Course (3-in < t < 5-in): NYSDOT No. 402.257904 (Type 3 Binder). Maximum 20% RAP permitted.
5. Shim Course: NYSDOT No. 402.058904 (Type 5 Shim). Maximum 20% RAP permitted.
6. Top Course: NYSDOT No. 402.127304 (Type 6.) Maximum 20% RAP permitted.
7. Top Course: NYSDOT No. 402.097304 (Type 7.) Maximum 20% RAP permitted.
8. Top Course: NYSDOT No. 402.097104 (Type 7F.) Maximum 20% RAP permitted.

B. Coatings/Fillers: Comply with New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.

1. Tack Coat: Emulsified asphalt

a. Slow setting type; NYSDOT Designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
b. Medium setting type; NYSDOT Designation 702-3401 (HFMS-2H) or 702-4301 (CMS-2h)

2. Asphalt Cement Filler: NYSDOT Designation 702-0700.

C. Water: Potable.

2.4 PAVEMENT MARKING PAINT

A. Complying with NYSDOT Standard Specifications:

1. Section 727-09: White and Yellow Solvent Borne Acrylic Permanent Traffic Paint

2. Colors:

a. White for asphalt striping and signage

1) Lane Markings for traffic in the same direction

b. Yellow for traffic markings

1) No parking parent / bus drop-off zones
2) No parking fire lanes
3) Lane Markings for opposing traffic
4) Parking Stalls – Confirm with owner

c. Blue for the following locations:

1) ADA Accessible symbol and associated ADA Accessible striping

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. TM 5626 White Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
b. TM 5627 Yellow Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
c. TM 2133 Blue Setfast Latex Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD

B. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. TM 5629 Black Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD

C. Complying with NYSDOT Standard Specifications:

1. Section 727-03: Epoxy Pavement Marking Coating Material

2. Colors:

   a. White for asphalt striping and signage

      1) Lane Markings for traffic in the same direction

   b. Yellow for traffic markings

      1) No parking parent / bus drop-off zones
      2) No parking fire lanes
      3) Lane Markings for opposing traffic
      4) Parking Stalls – Confirm with owner

   c. Lane Markings for opposing traffic Blue for the following locations:

      1) ADA accessible symbol and associated ADA accessible striping

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. EpoPlex "LS 50 White", two-component, 100% solids epoxy highway marking coating material, EpoPlex, Maple Shade, NJ 08052
   b. EpoPlex "LS 50 Yellow", two-component, 100% solids epoxy highway marking coating material, EpoPlex, Maple Shade, NJ 08052
   c. EpoPlex "LS 50 Custom Color (ADA Blue)", two-component, 100% solids epoxy highway marking coating material, EpoPlex, Maple Shade, NJ 08052

D. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. TM 5629 Black Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
      b. 3M Co., St. Paul, MN www.3m.com (888-364-3577)

E. Complying with NYSDOT Standard Specifications:

   1. Section 727-09: White and Yellow Acrylic Waterborne Permanent Traffic Paint

   2. Colors:

      a. White for asphalt striping and signage

         1) Lane Markings for traffic in the same direction

      b. Yellow for traffic markings

         1) No parking parent / bus drop-off zones

2) No parking fire lanes
3) Lane Markings for opposing traffic
4) Parking Stalls – Confirm with owner

c. Blue for the following locations:

1) ADA Accessible symbol and associated ADA Accessible striping

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. TM 226 White Setfast Acrylic Waterborne Traffic Paint, Sherwin Williams Company, Baltimore, MD
b. TM 227 Yellow Setfast Acrylic Waterborne Traffic Paint, Sherwin Williams Company, Baltimore, MD

2.5 AUXILIARY MATERIALS

A. Soil Stabilization Fabric: Refer to Section 31 20 00 "Earth Moving".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

a. Subsurface preparation shall conform to the appropriate section of NYSS.

4. After rolling, test course with straight edge min. 15 ft. long. Satisfactorily eliminate any depression over 1/4" deep.

5. Proceed with paving only after unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 SAWCUTTING

A. Saw cut existing pavement perpendicular to the roadway surface in neat lines. If the pavement breaks irregularly along the cut line during removal, saw cut the entire length of pavement again to achieve one uniform, straight, and neat line.

3.3 TACK COAT

A. Apply in accordance with NYSDOT Standard Specifications Section 407-3.02.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

B. Manhole and Catch Basin Frames and Grates:

1. Coat surfaces of frames and grates with oil to prevent asphalt adherence to surfaces. Do not tack coat.

3.4 PATCHING

A. Hot-Mix Asphalt Pavement:

1. Preparation: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending the minimum distance shown on Drawings into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade. Apply tack coat.

2. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3. Use hot-applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Herbicide Application: Obtain approval of Owner before herbicide notification or application. Notify Owner’s designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including all herbicides, insecticides and fungicides in accordance with the School Pesticide Neighbor Notification Law, Section 409-h of New York State Education Law and Commissioner's Regulation 155.24.

C. Tack Coat: Apply tack coat.

3.7 HOT-MIX ASPHALT PLACING

A. Hot-Mix Asphalt Paving Application: Provide finished surface free from depressions that could collect water. Satisfactorily remove, at Contractor's expense, any depressions over 1/8" when tested with 6-foot straight edge without evidence of patching. Carry all paving to wood stripping, curbing or to location shown on Drawings.

B. Application Over Aggregate Base:

1. Heavy Duty, Auto Duty and Light Duty Asphalt Areas: Apply over aggregate base in 2 courses. Comply with New York State Department of Transportation Standard Specification, Section 401 and Section 402, for asphalt types specified.

C. Placement: Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Spread mix at minimum temperature of 250 deg F.
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

D. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

7. Use hot-applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus 1/2 inch, no minus.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Pavement Surface Drainage: Pavement is to drain to catch basin, swale or other storm drainage control measure as indicated on Drawings or, if not indicated on drawings, to nearest storm drainage control measure.

D. Pavement Remediation: If pavement surface smoothness and drainage requirements above are not met, correct to meet tolerance and performance requirements. If remediation is not acceptable to Architect, removal and replacement of area will be required. Feather and smooth edges of correction measure so that joint is invisible.

3.11 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Perform work in accordance with NYSDOT Standard Specifications Section 727-09.

C. Sweep and clean surface to eliminate loose material and dust.

D. Surface must be clean, dry and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended application conditions (temperature, dew point, humidity) and rates to provide a minimum wet film thickness of 15 mils and minimum dry film thickness of 7.5 mils.

F. Do not apply pavement marking paint to concrete surfaces with concrete sealers or efflorescence. Remove by extended weathering, etching, or abrasive blasting.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
D. Replace and compact hot-mix asphalt where core tests were taken.
E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 FLOOD TESTING

A. Flood Tests: Perform flood test in the presence of the Architect using water tank truck to confirm that pavement surface smoothness and surface storm drainage requirements are met.

3.14 CLEANING AND DISPOSAL

A. Paver and Equipment Cleaning:

1. Do not clean tools and equipment used for HMA placement on the pavement surface, or near streams, ponds, drainage structures or other areas that are tributaries to waterways.

2. Use an area approved by the Owner’s Representative for cleaning all paving equipment and tools.

a. If possible, remove solid pieces of asphalt by scraping or other mechanical means prior to application of a cleaning agent.

3. If a petroleum product is used for cleaning, contain all liquid products during cleaning operations using tarpaulins, sand pads, pails, or other collection methods to prevent spillage or accidental release.

    a. Use hand sprayers or other similar devices to minimize the amount of petroleum product applied.

4. Properly dispose of sand and collected petroleum products as petroleum contaminated soil at no additional cost to the Owner.

B. Remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sidewalks.
2. Curbs and gutters.
3. Joint Sealant.
4. Concrete Sealer.
5. Curing materials.
6. Joint forming materials.
7. Joint Filler.
8. Sealers
9. Detectable Warning Materials.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Refer to Div 03 concrete section for concrete submittal requirements, material certificates, installer qualification data and other required action and informational submittals.

1.4 ACTION SUBMITTALS

A. Provide Product Data and Testing Information for each type of product indicated.

1. Forms
2. Form release agent
3. Sealer
4. Joint Sealant
5. Curing Compound
6. Expansion Joint Material
7. Expansion Joint Forming System
8. Detectable Warning Materials

1.5 SHOP DRAWINGS

A. Jointing Plan: Provide shop drawing showing concrete joint layout, specifically indicating the locations of expansion, tooled and control joints.

1.6 QUALITY ASSURANCE

A. For Installer and Manufacturer requirements, refer to Div 03 concrete section**.**

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship in the location and of the size indicated where directed by Architect and not less than 96 inches by 96 inches.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PREINSTALLATION MEETING

A. Concrete Paving Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place architectural concrete subcontractor.

2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 Refer to Div 03 concrete section for products, unless noted below.

2.2 FORMS

A. Form Materials: Metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

A. Refer to Div 03 concrete section for cementitious material, aggregates, admixtures, and other concrete materials.

2.4 FIBER REINFORCEMENT

A. Refer to Div 03 concrete section for fiber reinforcement materials.

2.5 CURING MATERIALS

A. Standard Concrete Curing Compound: Clear, Waterborne, Membrane-Forming Curing Compound in accordance with ASTM C 309, Type 1-D, Class B, dissipating, with fugitive dye. Minimum 2-coats required.

2.6 SEALER

A. Standard Concrete Sealer: Penetrating, Silane Sealer: Single component, 40% silane, waterbased slab sealer that forms chemical bond to the concrete. VOC compliant.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals; MasterProtect H 400.
b. Chem Masters; Aquanil Plus 40.
c. Dayton Superior Corporation; Weather Worker 40% J29WB.

2.7 JOINT SEALANT

A. Joint Sealant: Two-part, elastomeric polyurethane or polysulfide-based pourable self-leveling joint sealant complying with ASTM C 920, Type M, Grade P, Class 25, NT and CRD-C-506, Type 1, Classes A & B.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Building Systems; Sonolastic SL 2.

1) Color for uncolored concrete: Limestone.

b. W.R. Meadows, Inc.; Deck-O-Seal Sealant.

1) Color for uncolored concrete: Stone Gray.

2.8 EXPANSION JOINT MATERIALS

A. Expansion/Isolation-Joint-Filler Strips: ½-inch rigid, extruded polystyrene insulation (at exterior walls) ASTM D 1751; asphalt-saturated cellulosic fiber, or ASTM D 1752.

B. Plastic Expansion Joint Forming System ("Zip-Strip"): Plastic joint form plus cap.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following: (inserted space)

a. W.R. Meadows, Inc.; Snap-Cap.

2.9 DETECTABLE WARNING MATERIALS

A. Ductile iron detectable warning surface plates - for handicap accessible concrete curb ramps: Ductile iron, permanently embedded, wear and corrosion resistant 18-inch/24-inch/30-inch x 24-inch ductile iron plates with raised truncated domes complying with ADA and the NYS Building Code, having a skid resistance coefficient of friction greater than 0.8.

1. Physical Properties:

a. Slip Resistance ..... 1.10 Dry/1.06 Wet per ASTM C-1028
b. Wear Resistance ..... 7333 per ASTM C-501-84
c. Impact Resistance..... > 238 Newtons per ASTM D-1709
d. Bond Strength Adhesion to Concrete ..... > 5000 lbs per ASTM D-482
e. Tensile Strength..... > 35000 lbs per ASTM A-48
f. Design Compliance ..... Full Compliance with ADAAG / DOT

2. Hardware:

a. Manufacturer approved stainless steel hardware for bolting plates together

3. Coating:

a. Shop-dip applied black asphaltic coating.

4. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. East Jordan Iron Works, Inc. (EJIW): Duralast Cast Iron Detectable Warning Plates.

2.10 CONCRETE MIXTURES

A. Refer to Div 03 concrete section for concrete mixtures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving in accordance with Section 31 20 00 “Earth Moving”. Identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

3.4 STEEL REINFORCEMENT

A. Refer to Div 03 concrete section for steel reinforcement.

3.5 JOINTS

A. General: Form construction, expansion/isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Expansion / Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 30 feet maximum unless otherwise indicated.

2. Extend joint fillers full width and depth of joint.

3. Plastic Expansion Joint Forming System (“Zip Strip”). Install so that cap of channel is flush with surrounding concrete pavement. Install per manufacturer’s installation instructions. Remove plastic cap after concrete is cured.

4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

D. Control / Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving unless otherwise noted:

1. Tooled / Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Tooled / Grooved and Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks. Sawed joints without tooling are not allowed.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Refer to Div 03 concrete section for concrete placement information.

B. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

C. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

D. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

E. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

F. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, (4.3.2.1 Slump Adjustment).

1. With each concrete mixture submittal, indicate amounts of mixing water to be withheld for later addition at Project site.

2. Water added must not increase the water-cement ratio past the approved mix design ratio.

3. Add additional water reducer or plasticizer to mix instead of adding water to achieve flowable, workable concrete. Do not add water to concrete after adding these admixtures to mixture.

4. Do not add water after truck is more than half empty.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

I. Screed paving surface with a straightedge and strike off.

J. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

K. Machine-Placed Curbs and Gutters: Allowed only upon Architect approval. Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

L. Slip-Form Paving: Allowed only upon Architect approval. Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

M. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 DETECTABLE WARNINGS

A. Cast Iron Detectable Warning Surface Plates:

1. Connection: Fasten plates together with stainless steel bolts per manufacturer’s torque requirements.

2. Setting Plates: Set cast iron detectable warning plates into wet concrete in accordance with ADAAG (American Disabilities Act and Accessibility Guidelines). Tamp plates thoroughly with rubber mallet until concrete seeps through vent holes.

3. Clean off excess concrete from the plate(s) and adjust adjacent concrete to be flush with plates. Finish concrete around plates to match surrounding concrete.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 and 305R for hot-weather protection during curing.

B. Slabs: Protect slabs within building from precipitation accumulation. Immediately remove water, snow or ice from surface of slabs within building regardless if source is from precipitation, construction activities, etc.

C. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Formed Surfaces: Cure formed concrete surfaces, including supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

F. Cure concrete according to ACI 308.1:

1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Refer to Div 03 concrete section for field quality control information.

1. Contractor Requirements:

a. Provide access to concrete construction for representatives of testing agency employed by Owner to perform concrete testing.
b. Notify Architect at least four days in advance of each concrete placement to allow notification of Owner's testing agency.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 16 40 – STONE CURBS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stone curbs.

1.3 SUBMITTALS

A. General: Submit all action submittals (except Samples for Verification) required by this Section concurrently.

B. Action Submittals:

1. Product Data: For the following:

a. Mortar materials.
b. Stone curbs.

2. Samples for Initial Selection: For the following:

a. Granite for stone curbs.

3. Samples for Verification:

a. Granite, of selected color, not less than 12 x 12 x 3 inches in size, showing top and face finishes.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of stone curb from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

1. Mockup: Build mockup to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store stone curbs on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace stone curb work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 CURBS

A. Stone Curbs: Granite curbing, produced in random lengths not less than 36 inches from granite complying with ASTM C 615.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fletcher Granite Company, Inc.
    b. Polycor Inc.
    c. Swenson Granite Co.

2. Granite Color and Grain: Light gray with fine grain.

3. Total Height: 16 inches.

4. Top Width: 5 inches.

5. Top Finish: Sawed top surface, with no projections or depressions greater than 1/2-inch.

6. Height top to bottom: 15” minimum.

7. Face Height: 6 inches.

8. Face Finish: Smooth quarry split with no projections greater than 3/4-inch or depression greater than 1/2-inch down to 2 inches below grade line. Vertical face at right angle to plane of top.

9. Back: Parallel to face.

10. Ends: Right angle to face, unless noted otherwise.

11. Edges: “Buzzed Edge” at exposed edge at face of curb – ¼” minimum.

12. Curved Sections: Curb segments on curves with radii of 100 feet or less shaped to the required curvature, with the ends cut on radial lines.

13. Special Shapes: As indicated.

14. Granite (stone) curb shall conform to NYSDOT Standard Specification 609 and Standard Sheet 609-01. Curb shall be the Top Width noted above and Type C. Exposure Height may vary.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II.
B. Sand: ASTM C 144.
C. Water: Potable.

2.3 MORTAR MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce joint materials of uniform quality and with optimum performance characteristics. Discard mortar if it has reached its initial set before being used.

1. Mortar Proportion: Equal parts Portland cement and sand with sufficient water to make a workable mixture.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive stone curbing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION, GENERAL

A. Do not use stone curbs with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Cut stone curbs with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to fit adjoining work neatly. Use full units without cutting where possible.

C. Tolerances: Do not exceed 1/8-inch unit-to-unit offset from flush and 1/4 inch in 10 feet from level, or indicated slope, for finished top surface of curbing.

D. Expansion Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide backing for sealant-filled joints. Sealant materials and installation are specified in Division 07 Section "Joint Sealants."

1. Unless noted otherwise, provide expansion joints at 30 foot intervals.

E. Install stone curb sections on continuous dry-mix concrete leveling bed, true to line and grade. Provide continuous concrete collar support.

F. Fill joints with mortar (except at expansion joints), rodding in place, with the top and exposed face neatly pointed flush.

G. Spaced Joint Widths: Provide 1/2-inch nominal joint width.

3.3 REPAIRING, POINTING, AND CLEANING

A. Remove and replace stone curbs that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess mortar from exposed surfaces; wash and scrub clean.

END OF SECTION 32 16 40

SECTION 32 18 23.13 – BASEBALL FIELD SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Baseball infield mix and additives.

1.3 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with the other specified requirements, the most restrictive requirements shall govern.

1. National Federation of State High School Associations (NFSHSA).
2. American Sports Builders Association (ASBA)
3. Manufacture's Data and Recommended Installation Requirements.
4. New York State Public High School Athletic Association Inc. (NYSPHSAA)

1.4 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

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

2. Samples for Verification: For each type of baseball infield mix indicated.

a. Minimum 2-quart sample sealed in a container.

C. Informational Submittals:

1. Material Certificates: For each type of baseball infield mix and additive, from manufacturer.

D. Closeout Submittals:

1. Field quality-control reports.
2. Maintenance Data: For baseball infield system to include in maintenance manuals.

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit baseball infield system installation to be performed according to manufacturers' written instructions.

PART 2 - PRODUCTS

2.1 INFIELD MIX AND ADDITIVES

A. Baseball Diamond Mix: Clean sand, sharp, free from loam, clay lumps, or other deleterious materials, and complying with the following requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
#4	95 to 100
#10	95 to 100
#20	65 to 75
#60	55 to 65
#100	45 to 55
#200	40 to 50

1. Particle Size Analysis:

   a. Sand: 65 to 75 percent.
   b. Silt: 10 to 20 percent.
   c. Clay: 10 to 20 percent.

2. pH Level: Plus or minus 6.8 percent.

3. Color: Orange to reddish orange.

4. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Marco Clay, “20 Series Standard” or other approved mix by Northern Nurseries.
   b. DuraEdge “Classic Infield Mix”, by Natural Sand Company, Inc, Slippery Rock, Pa.
   c. Beam Clay, “Original Premium” or other approved mix by Parteac Peat Corporation, Great Meadows, New Jersey.

B. Baseball Mound Material: Silica blend, sharp, free from loam, clay lumps, or other deleterious materials.

1. Color: Gray.
2. Basis-of Design Product: Subject to compliance with requirements, provide Profile Products LLC, Turface Professional Mound Clay; or comparable product.

C. Baseball/Softball Mix Conditioner/Drying Agent (Diatomaceous Earth Type): Diatomaceous earth meeting ISO 9002 standards; crushed, dried, kiln-fired and screened to particle size.

1. Basis-of Design Product: Subject to compliance with requirements, provide EP Minerals LLC, PlayBall! Regular Infield Conditioner; or comparable product.

D. Baseball/Softball Mix Conditioner/Drying Agent (Calcined Clay Type): Silica, illite clay and montmorillonite blend with 40 to 60 percent minimum amorphous silica, free from dust, loam, clay, or other deleterious materials.

1. Basis-of Design Product: Subject to compliance with requirements, provide Profile Products LLC, Turface MVP; or comparable product.

E. Baseball/Softball Base Path Additive: Non-toxic, odorless, non-staining, concentrated organic powder stabilizer binding baseball mix together creating natural appearing firm surface.

1. Basis-of Design Product: Subject to compliance with requirements, provide Stabilizer Solutions, Inc., Stabilizer; or comparable product.

F. Warning Track Material: 3/16-inch red argillite aggregate material.

1. Basis-of Design Product: Subject to compliance with requirements, provide Partac Peat Corporation, 3/16” Red Warning Track; or comparable product.

2.2 CONCRETE SAND

A. Concrete Sand for Baseball Diamond: Clean sand, sharp, free from loam, clay, or other deleterious materials, and complying with New York State Department of Transportation (NYSDOT) Standard Specifications, Section 703-07 Concrete Sand. When dry, the fine aggregate shall conform to the following gradation requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
3/8 inch	100 min
No. 4	90 to 100
No. 8	75 to 100
No. 16	50 to 87

No. 30	25 to 62
No. 50	10 to 30
No. 100	1 to 10
No. 200 (Wet)	0 to 3

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, subgrade and substrate conditions, drainage, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. General: Prepare substrates to receive surfacing products according to baseball infield system manufacturer's written instructions. Verify that substrates are sound, at required elevation, and without high spots, ridges, holes, and depressions.

3.3 INSTALLATION

A. General: Comply with baseball infield system manufacturer's written installation instructions. Install baseball infield system over area and in thickness indicated, allowing for compaction.

1. Pitcher's Mound: Construct in accordance with system manufacturer's written installation instructions, to meet required height, with a gradual transition to surrounding grade.

2. Catcher's Area / Batter's Box: Construct in accordance with system manufacturer's written installation instructions, to meet required home plate elevations and distance from pitcher's rubber, with smooth transition to adjacent turf areas.

B. Verify that infield subgrade is graded so that the application of infield mix to required depths will meet proposed grades.

C. Install 6" flexible wood forms at entire edge of skinned area.

D. Spread layer of sand if required.

E. Placing: Uniformly spread baseball infield system according to manufacturer's written instructions to an even surface free from irregular surface changes as indicated. Grade the edge of the infield where it meets the wood forms to be a flush, level transition to turf.

F. Install baseball/softball mix conditioner in accordance with manufacturer's written installation instructions, at the following rate:

1. Diatomaceous Earth Type: 10 percent of infield mix.
2. Calcined Clay Type: 25 percent of infield mix.

G. Install first base runway material if required.

H. Compacting and Grading: Dampen infield with water and uniformly compact and grade baseball infield system according to manufacturer's written instructions to an even surface free from irregular surface changes as indicated. Grade edge of infield where it meets turf so that a flush, level transition is achieved.

1. Verify that grades are accurate and repair low and high spots. Make corrections necessary for all water to drain away from infield and for a smooth transition between infield and turf. Verify that no tripping hazards at turf edge are present.

I. Finish Grading: Drag, rake, or screen to loosen up top surface and achieve a smooth finished surface at required elevations.

J. If field is completed in the fall, leave wood forms in place through the winter. In the spring before the playing season begins, remove wood forms. Add additional infield mix if required to achieve a smooth transition to turf.

K. Rake to remove weeks and smooth surface before requesting substantial completion inspection.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Remove and replace applications of baseball infield system where test results indicate that it does not comply with requirements.
C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with requirements.

3.5 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 32 18 23.13

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Baseball Backstop
3. Gates: Swing.
4. Gates: Premanufactured gate with panic bar
5. Cantilever Slide Gate
6. Privacy Slats
7. Mowing strip weed barrier
8. Chain link fence cap
9. Chain link fence wind screen

B. Related Sections:

1. Section 03 30 00 “Cast-in-Place Concrete”
2. Section 31 20 00 "Earth Moving"

1.3 REFERENCES

A. ASTM A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
B. ASTM F552 Standard Terminology Relating to Chain Link Fencing.
C. ASTM F567 Standard Practice for Installation of Chain Link Fence.
D. ASTM F626 Specification for Fence Fittings.
E. ASTM F900 Specification for Industrial and Commercial Swing Gates.
F. ASTM F1083 Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
G. ASTM F1184 Specification for Industrial and Commercial Horizontal Slide Gates.
H. CLFMI WLG2445 Chain Link Fence Wind Load Guide for the Selection of Line Post and Line Post Spacing.

1.4 PERFORMANCE REQUIREMENTS

A. Design Wind Load: Comply with applicable requirements of building code in effect for Project including applicable portions of ASCE 7 for Wind Load Pressure and CLFMI WLG 2445 Wind Load Guide for the Selection of Line Post Spacings.

1.5 SUBMITTALS

A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

   a. Fence and gate posts, rails, and fittings.

   b. Chain-link fabric, reinforcements, and attachments.

   c. Chain-link cantilever slide gate, and attachments.

   d. Polymer and polyester coatings.

      1) Note: Polymer and polyester coated samples and product data are to be submitted simultaneously.

   e. Accessories:

      1) Privacy slats
      2) Mowing strip weed barrier
      3) Chain link fence cap
      4) Chain link fence wind screen

   f. Gates and hardware.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

3. Warranty:

   a. Sample of special warranty
   b. Sample of manufacturer warranty

C. Informational Submittals:

1. Product Test Reports: For framing strength according to ASTMF 1043.

D. Closeout Submittals:

1. Operation and Maintenance Data: For the following to include in operation and maintenance manuals:

   a. Polymer and polyester finishes.
   b. Gate hardware.

2. Warranty: Executed special warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Minimum five (5) years' experience in installing chain link fences and gates similar in material, design, and extent to that indicated for this Project in accordance with ASTM F 567, whose work has resulted in construction with a record of successful performance.

B. Mockups: If required by Architect, build mockups to set quality standards for fabrication and installation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Contractor's warranty to repair or replace components of chain-link fences and gates that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of any component of fence to perform as designed.
b. Faulty operation of gate(s) to perform as designed.

2. Warranty Period: Five (5) years from date of Substantial Completion.

B. Manufacturer warranty: Manufacturer's standard form in which Contractor agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, coatings and other materials of the fence components, including fabric, framework and fittings.

2. Warranty Period: Fifteen (15) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.

2. Steel Wire Fabric:

a. General Use: Wire with a diameter of 0.148 inch (9 gauge) minimum. For polymer coated fabric, wire with a diameter of 0.148 inch core (9 gauge core) minimum.

b. Baseball/Softball Backstops and Wings:

1) Up to 6 feet in height (or as indicated on drawings): 0.192 inch (6-gauge) core minimum.
2) Above 6 feet in height (or as indicated on drawings): 0.148 inch (9-gauge) core minimum.

c. Dugout Fencing: 0.148 inch (9-gauge) core minimum.

d. Tennis Court Fencing: 0.120 inch (11-gauge) core minimum.

3. Mesh Size:

a. General Use: 2 inches, unless noted otherwise.

b. Tennis Court Fencing: 1-3/4 inch mesh.

c. Baseball and Softball Backstop:

1) Bottom panels: 1-3/4 inch mesh
2) Remaining panels and hood: 2 inch mesh

4. Coatings:

a. Polymer-Coated (Vinyl) Fabric: ASTM F 668, Table 4, Class 2b, fused and adhered over zinc-coated steel wire.

1) Color: Black, complying with ASTM F 934.

2) Basis of Design Manufacturer: Subject to compliance with requirements, polymer coating that may be incorporated into the Work include, but are not limited to, the following:

a) Merchants Metals Brighton Colorcoat II fused and adhered polymer coating.

5. Selvage: Knuckled at both selvages.

2.2 FRAMEWORK MATERIALS

A. Posts and Rails: Comply with ASTM F 1043 for minimum dimensions and wall thickness of framing, including rails, braces, and line; terminal; and corner posts, meeting the following criteria:

1. Heavy Industrial Strength: ASTM F 1043 Group I-C, SS40, round steel electric-resistance-welded pipe galvanized with hot-dip process in accordance with ASTM A653/A653M and ASTM A924/A924M.

2. Manufactured to meet minimum yield strength of 50,000 psi and coated in accordance with the following standards:

   a. ASTM F1043, Group IC, Electrical Resistance Welded Round Steel Pipe, heavy industrial weight.
   b. M181, Type I, Grade 2, Electrical Resistance Welded Steel Pipe
   c. RR-R 191/3, Class 1, Grade B, Electrical Resistance Welded Steel Pipe.

B. Coatings:

1. Zinc Coating:

   a. Zinc coating to conform to ASTM B6 and the weight range (external and internal) of ASTM F1043, Type B. Exterior surface of the weld to be recoated with the same material and thickness as the basic zinc coating.

   b. Weight of the zinc to be determined through ASTM A90, 1.8 w/ PVC, 2.0 oz w/o vinyl.

   c. Final coat to be a clear acrylic finish.

2. PVC / Polyester Coating Over Zinc Coating:

   a. Thermoplastic vinyl finish to be 10 mils (minimum) thick.

   b. Cleaning and Surface Preparation: Consists of a four-stage pretreatment/wash, an iron phosphate coating and immersion in a water based epoxy primer.

   c. PVC Coating Application: Coating is thermally fused to heated pipe meeting the following standards:

      1) ASTM F1043 Group I-C, Heavy Industrial.
      2) Federal specification RR-F-191/3E, Class 1
      3) Shows satisfactory adhesion in cross-hatch test, Method B, ASTM D3359.
      4) Finish shall not crack, blister or split under normal use.

3. Color: Match chain-link fabric, complying with ASTM F 934, Standard Colors for Polymer-Coated Chain Link Fence Materials.

C. Basis of Design Manufacturer: Subject to compliance with requirements, framework and coatings that may be incorporated into the Work include, but are not limited to, the following:

1. Merchants Metals Colorbond Chain Link Fence Framework and Coating System.
2. Master Halco Permafused II Heavy Mil PVC Chain Link Fence Framework and Coating System.
3. Ameristar PermaCoat PC-40 (industrial weight), manufactured by Ameristar Fence Products (www.ameristarfence.com) Chain Link Fence Framework and Coating System.

2.3 FRAMEWORK SIZES

A. Line Post Size (determined by height):

1.	4 feet up to and including 6 feet high:	2 inches o.d.
2.	7 feet up to and including 9 feet high:	2-1/2 inches o.d.
3.	10 feet up to and including 12 feet high:	3 inches o.d.
4.	Over 12 feet to 16 feet high:	4 inches o.d.

B. End, Corner and Pull Post:

1.	4 feet up to and including 6 feet high:	2-1/2 inches o.d.
2.	7 feet up to and including 9 feet high:	3 inches o.d.
3.	10 feet up to and including 12 feet high:	4 inches o.d.
4.	Over 12 feet to 16 feet high:	4 inches o.d.

C. Baseball Backstop Posts Sizes: Refer to Drawings and Details.

D. Horizontal Framework Members: Intermediate, top and bottom rails complying with ASTM F 1043. Size in accordance with the following guidelines unless otherwise indicated on drawings:

1. Top, Intermediate and Bottom Rail: 1.66 inches in diameter.

   a. Bottom Rail: Provide bottom rail for:

      1) Fence 9 feet high and over
      2) Fencing at baseball foul lines

   b. Intermediate Rail: Provide intermediate rail for:

      1) Fencing 10 feet high and over,
      2) Tennis / basketball court fencing

   c. Baseball Backstop horizontal framework sizes: Refer to Drawings and Details.

2. Brace Rails: Comply with ASTM F 1043.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: For use on fencing with zinc coated fence fabric. 0.177-inch-diameter (7 gauge), marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:

1. Type II, zinc coated (galvanized) with the following minimum coating weight:

   a. Matching chain-link fabric coating weight.

B. Polymer-Coated Steel Wire: For use on fencing with polymer coated fence fabric. 0.177-inch-diameter (7 gauge core), tension wire complying with ASTM F 1664, Class 2b over zinc-coated steel wire.

1. Color: Match chain-link fabric, complying with ASTM F 934.

2.5 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post. Post caps to be weather-tight, securely fastened and vandal-resistant.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel. Length not less than 2 inches shorter than full height of chain-link fabric with minimum cross-section of 3/16 inch x 3/4 inch. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading. Provide rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

a. General Use Fencing including Foul Line, Outfield and Tennis Court Fencing:

1) Aluminum: ASTM B 211; Alloy 1350-H19; 0.148-inch-diameter, mill-finished wire. Coating to match chain-link fence fabric. (Provide coating to match framework.)

b. Baseball and Softball Backstops and Dugouts:

1) Hot-Dip Galvanized Steel: 0.148-inch (9 gauge core) diameter wire. Coating to match chain-link fence fabric. Provide coating to match framework.

2. Hog Rings: For attaching chain link fabric to bottom tension wire.

a. Material: Aluminum per ASTM B 211; Alloy 1350-H19; 0.192 inch (6 gauge), mill-finished wire.

I. Fitting Finish:

1. Steel or cast iron: Galvanized Coating for Pressed Steel or Cast Iron - Not less than 1.2 oz. /sq. ft. zinc.

a. Coating - Vinyl-coated per ASTM F 626.

2. Color: To match color of fence fabric.

J. Fasteners:

1. Material to be stainless steel.

a. Coating - Vinyl-coated per ASTM F 626**.**

2. Color: To match color of fence fabric.

3. Finish: Install fasteners that are no more than ¼ Inch long.

2.6 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.

1. Gate Leaf Width: 48 inches unless otherwise noted on drawings.
2. Gate Fabric Height: As indicated on drawings.

B. Pipe and Tubing:

1. Coating and finish to match fence framing.

2. Gate Post Size:

a. For gate heights over 6', and if gate height is equal to fence height, then standard fence framing end post requirements shall apply. Refer to Post and Rail requirements.

b. Gate Leaf up to 6 feet Wide: 2.875 inches o.d.; 4.64 lbs./l.f.

c. Gate Leaf over 6 feet and under 12 feet wide: 4 inches o.d.; 6.56 lbs./lin. ft. (weight applicable to Group IC SS40 framework only)

d. Gate Leaf over 12 feet Wide: 6.625 inches o.d.; 19 lbs./lin. ft.; or 4.5 inches o.d. (applicable to Group IC SS40 material complying with ASTM F 1043 only and upon approval of framework material by Architect.)

C. Frame Corner Construction: Welded.

D. Swing Gate Hardware:

1. Hinges: 180-degree inward swing unless otherwise noted on Drawings.

2. Latches: Commercial latch permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

3. Padlock and Chain: Owner furnished.

4. Keeper: Provide keeper for all vehicular gates, which automatically engages gate leaf and holds it in open position until manually released. Provide sleeve to insert keeper. For concrete paving, set sleeve directly into concrete. For asphalt paving set sleeve into concrete collar.

5. Double Gates: Provide drop bar for all double gates, consisting of hot-dipped galvanized rod that drops into concrete collar. Provide locking device and padlock eyes as an integral part of the latch, requiring one padlock for locking both gate leaves.

6. Closer: Manufacturer's standard.

7. Color: To match fence fabric.

2.7 FENCE POST ROUND CONCRETE FORM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Sonoco Sonotube Concrete Forms or comparable product.

2.8 PREMANUFACTURED GATE WITH PANIC BAR

A. Premanufactured chain link gate with panic bar to include the following components:

1. Posts: 3” square steel.

2. Frame: 2” square steel.

3. Chain Link Fabric: 2” mesh; 9 gauge core with fused and adhered vinyl coating meeting the specifications above. Color to match fencing.

4. Panic Bar Plate: Steel plate securely attached to gate frame.

5. Hardware: Pressed steel hinges attached to post allow gate leaf to swing 180°.

6. Options:

a. Panic Bar Exiting Device: Exterior grade weather resistant Stainless Steel Latch Mechanism.

b. Handle: Metal handle on opposing side from panic bar.

c. Outside Access Hardware: Standard key cylinder lock allowing access from outside with key. Panic bar exiting device with outside key release trim allowing free entrance.

d. Hydraulic gate closer.

e. Metal stop bar and latch.

7. Post Caps: Cast malleable iron or formed steel welded to uprights.

a. Cap style: Flat.

8. Coating: All components with the exception of the panic bar and related accessories to be coated with baked powdercoated finish:

a. Primer coat: Zinc enriched powder primer coat at 2-4 mils.
b. Polyester finish powder coat at 2-4 mils.
c. Color to be chosen by Architect from manufacturer's standard color palate.

9. Basis of Design: Subject to compliance with requirements, premanufactured gate manufacturer includes, but is not limited to: Merchants Metals, Tuf Guard Prehung Chain Link Gate with Panic Bar and Handle.

2.9 CHAIN LINK CANTILEVER SLIDE GATE

A. Gate Frame: Fabricated in accordance with ASTM F1184, Class 2, using 2" square aluminum members, ASTM B221, alloy and temper 6063-T6, weighing 0.94 lb./ft. Members welded together forming rigid on-piece frame integral with top track. 2 truck assemblies provided for each gate leaf unless otherwise specified. Gates over 27 ft. in single opening shipped in 2 parts and field spliced with manufacturer's special attachments.

1. Internal Uprights: 2" x 2" aluminum members welded in gate frames, at approximately 8 ft. o.c., subdividing frame into panels.

a. Single Gate Leaf (up to 22 ft. wide):

Gate Leaf Sizes	Cantilever Support (overhang)
6 ft - 10 ft	6'-6"
11ft - 14 ft	7'-6"
15 ft. - 22 ft.	10'-0"

b. Single Gate Leaf (23 ft. to 30 ft. wide) and Bi-Parting Double Gate (46 ft. to 60 ft. wide): Additional 2" square lateral support rail welded adjacent to top horizontal rail, and 2" x 4" aluminum bottom rail provided weighing 1.71 lbs./ft.

Gate Leaf Sizes	Cantilever Support (overhang)
23 ft - 30 ft	12'-0"

c. Single Gate Leaf (31 ft. to 40 ft. wide) and Bi-Parting Double Gate (62 ft. to 80 ft. wide): 2 top track/rails welded together forming dual enclosed track, and 2 ea. truck assemblies provided for each track for each gate leaf for total of 4 truck assemblies. 2" x 4" aluminum bottom rail provided weighing 1.71 lbs./ft.

Gate Leaf Sizes	Cantilever Support (overhang)
31 ft - 35 ft	13'-6"
36ft - 40 ft	16'-0"

d. Single Gate Leaf (41 ft. to 50 ft. wide) and Bi-Parting Double Gate (82 ft. to 100 ft. wide): 24" wide rigid box frame truss fabricated consisting of dual side frames similar to standard single leaf gates, separated by square cross members and diagonal truss rod bridging. Dual side frames contain top track/rail providing support for truss from both sides. 4 trucks provided for each track for total of 8 trucks for each gate leaf. Steel plate welded between top of support posts to maintain truck assemblies in alignment with tracks.

Gate Leaf Sizes	Cantilever Support (overhang)
41 ft - 50 ft	Custom engineered by manufacturer

e. Bottom of gate shall be constructed to be parallel to ground elevations with the top rail of the gate level. The bottom of gate shall be 6” above existing/finished grade. If the bottom of gate requires a wedge-shaped gate section be constructed, the gate structure shall be designed to accommodate for this additional fence material and structure.

2. Chain Link Fence Fabric: Unless otherwise indicated, provide No. 9 gauge core (0.148") steel wires, 2" mesh, with top and bottom selvages knuckled, complying with ASTM A-491. Provide one-piece fabric widths for fencing up to 12 ft. high.

   a. Fabric Finish: Aluminum coated, with not less than 0.40 oz. aluminum coating per sq. ft. of wire surface per ASTM A-428.

   b. Fabric Finish: Plasticized PVC coating per ASTM F-668 extrusion bonded to galvanized wire in accordance with FS RR-F-191 H/IB, Plasticized PVC coating per ASTM F-668 extrusion bonded to galvanized wire in accordance with FS RR-F-191 H/IB

3. Bracing: Diagonal adjustable length 3/8" galvanized steel truss rods in each panel of gate frames.

4. Top Track/Rail: Enclosed, combination one-piece track and rail, aluminum extrusion weighing 3.72 lbs/ft. and designed to withstand reaction load of 2,000 lbs. Track not coated with PVC.

5. Truck Assembly: Swivel type, zinc die cast, with 4 sealed lubricant ball bearing rollers, 2" diam. x 9/16" wide and 2 side rolling wheels ensuring truck alignment in track. Trucks mounted on post brackets using 7/8" diam. ball bolts with 1/2" shank. Trucks designed to withstand same reaction load as track.

6. Gate Hangers, Latches, Brackets, Guide Assemblies, and Stops: Malleable iron or steel, galvanized after fabrication and including positive latch with provision for padlocking. Fittings not coated with PVC.

7. Bottom Guide Wheel Assemblies: Consists of 2 ea. 4" diam. rubber wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. One assembly attached to each guide post. Fitting not coated with PVC.

8. Gate Posts: Galvanized steel, 4" O.D. Schedule 40 pipe, weighing 9.1 lbs/ft., with 1 latch post and 2 support posts for single slide gates and 4 support posts for double slide gates.

9. Gate Posts: Galvanized steel, 3" square tube, weighing 7.04 lbs/ft., with 1 latch post and 2 support posts for single slide gates and 4 support posts for double slide gates.

10. Finish: Match fence.

11. Concrete: Minimum 28 day compressive strength of 3,000 psi.

12. Post Bracket: Flange type base plates with 4 holes for surface mounting of posts where indicated.]

2.10 PRIVACY SLATS – 90 Percent Coverage

A. Material: Heavy duty polyethylene reinforced tubular slats with "wings":

1. Provide 90% coverage.
2. Slats must span full height of fence (i.e., no partial height slats).
3. Slat Width: 1 7/16" for 2" Mesh Size.
4. Manufactured for chain-link fences from virgin polyethylene containing UV inhibitor.
5. Sized to fit mesh specified with vandal-resistant fasteners and lock strips.
6. Installed vertically.
7. Verify wind-loading is appropriate for fencing specified and application.

B. Color: As selected by Architect from manufacturer's full range.

2.11 MOWING STRIP WEED BARRIER

A. At all areas of new chain link fencing in lawn, provide mowing strip weed barrier product equal to MowStrip Fence Underlayment Plastic Weed Barrier, by Wildfire Products, Fargo ND 58106.

B. Material Requirements

1. 10½" width
2. UV resistant, flexible molded plastic
3. Color: Green

4. 6', 8' 10' interlocking sections
5. Universal intersection matching fence post sizing

2.12 CHAIN LINK FENCE CAP

A. Description:

1. Basis-of Design-Product: Subject to compliance with requirements, provide "Premium Fence Guard" Fence Cap (Product #01166); or equivalent product supplied by: Mid-America Sports Advantage, Inc. M.A.S.A. / Osborne Innovative Products, 1413 S. Meridian Road, Jasper, Indiana 47546 Telephone: 1-800-264-4519, Web: www.sportsadvantage.com

2. Product Specification:

   a. Material: Polyethylene

   b. Size: 3 inch wide, 4½ inch tall

   c. Shape: Professional teardrop shaped profile

   d. Weather-treated and UV protected

   e. Color:

      1) Outfield fence fair territory other than batters eye – Blue.
      2) Batter's Eye of outfield fence fair territory – Typical Length 90 ft - Blue.
      3) Outfield fence foul territory fence areas - Yellow.
      4) Sideline fence – Yellow.
      5) Other locations – Blue.

   f. Installation: On top of chain link fencing. Secure with matching color UV resistant, plastic fence cap ties, installed every two (2) feet

   g. Thickness: 0.10 inch Wall Thickness

   h. Warranty: Minimum 5 Year.

2.13 CHAIN LINK FENCE WIND SCREEN

A. Description:

1. Basis-of-Design Product: Subject to compliance with requirements, provide "Vinyl Coated Polyester (VCP) – Open Mesh" windscreen (Item 21620); or equivalent product supplied by: Douglas Industries, Inc., 3441 S 11th Ave., IA 52748 Telephone: 1-800-553-8907, Web: www.douglas-sports.com

2. Material Requirements:

   a. Size: 6'-high chain link fence coverage. Screen to completely cover fence panel height in one piece.
   b. 50% vinyl, 50% polyester
   c. Open Mesh - 9 x 12 weave
   d. 80% Windbreak
   e. 7.0oz. Sq yd
   f. 230 x 200 Tensile Strength
   g. 3-Year limited warranty

3. Provide factory installed Air Venting die-cut and heat sealed (Douglas AV Item 21001, or equivalent) for each chain link fence section between posts.

4. Color: Coordinate with Owner regarding color selection from standard palette of available colors.

5. Graphics / Text: Provide custom lettering and/or logos as indicated in the drawings. Coordinate with Owner regarding final color / font / letter height and logo design and layout requirements.

2.14 CONCRETE

A. Concrete Footings: Refer to Division 03 concrete section for cast-in-place concrete, ASTM F 567 Section 5 and Drawings and Details for footing size. Bottom of footing must not be smaller than the top to prevent frost heaving.

2.15 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and compatible with galvanized and clear coatings. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications. To be compatible with galvanized and clear coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil. Mechanically driven posts only allowed if shown on Drawings or specifically approved by Architect.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

    a. Concrete Fill: Minimum 28-day compressive strength 3,000 psi (20 MPa). Refer to Division 03 Section "Cast-in-Place Concrete."
    b. Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

C. Types of Post Footings: As indicated on Drawing or as approved by Architect.

1. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

2. Concealed Concrete: As indicated on Drawings to allow covering with surface material.

3. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

E. Line Posts:

1. General Use Fencing: Space line posts uniformly at 10 feet o.c. unless otherwise indicated on Drawings.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with hog rings spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along bottom of fence fabric. Install bottom within 6 inches of bottom of fabric and tie to each post with tie wires.

H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps / loop caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps / loop caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer. Connection sleeves to be located / supported by post caps / loop caps.

I. Intermediate and Bottom Rails: Install and secure to posts with fittings.

J. Chain-Link Fabric: Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

1. Height of fabric between finished grade and bottom selvage.

a. General Use: Leave 2 inches between finished grade or surface and bottom of selvage unless otherwise indicated.

2. Fabric installation on fence posts relative to adjacent use:

a. General Use: Apply fabric to inside of enclosing fence posts / framework as indicated on Drawings.
b. Baseball Fencing: Apply fabric to inside (field side) of enclosing fence posts / framework.

K. Tension or Stretcher Bars: Thread bar through first row of diamonds of fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Aluminum ties: Both ends of the tie are to make two complete wraps around wire pickets. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
2. Privacy Slats: Install slats in direction indicated, securely locked in place, vertically.

3.5 FENCE INSTALLATION ADJACENT TO BUILDING WALL OR COLUMN

A. Install fencing and gates with maximum 2” gap between fence post and building wall or column unless otherwise noted.

3.6 SWING GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.7 CHAIN LINK CANTILEVER SLIDE GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.8 PREMANUFACTURED GATE WITH PANIC BAR INSTALLATION

A. Install gate per manufacturer’s installation instruction.
B. Shipping bar to be installed below grade.
C. Attach all hardware to gate so that it works properly and cannot be removed by unauthorized persons.
D. Set posts in concrete.

3.9 MOWING STRIP WEED BARRIER

A. Installation per manufacturers requirements
B. On all new post installations, intersection connector shall be installed around posts by sliding over posts, not by cutting connector. Connector can be cut only for existing posts.

3.10 CHAIN LINK FENCE CAP

A. Installation per manufacturers requirements
B. Where two difference section of chain link fence cap meet, provide a 6-inch overlap between sections.

3.11 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

3.13 COMPLETION AND CLEAN UP

A. Leave the area of installation free of debris and excess soil, concrete, and gravel resulting from installation of the fence. Clean fencing of concrete slurry, hydroseeding overspray and any other excess material. Seed and mulch all areas around the fencing where bare earth is left exposed.

END OF SECTION 32 31 13

SECTION 32 50 00 - BOLLARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fabricated metal bollards.
2. Bollard covers.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Fabricated metal bollards.
2. Bollard covers.

B. Shop Drawings: Show fabrication and installation details for bollards.

1. Include plans, elevations, sections, and details of bollards and their connections. Show anchorage and accessory items.

1.5 INFORMATIONAL SUBMITTALS

A. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats. Refer to Section 09 96 00, “High Performance Coatings” for painting fabricated bollards requirements.

1.6 QUALITY ASSURANCE

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

B. Pre-Fabricated Metals Bollards Warranty: Provide manufacturer's standard limited warranty that the bollards will remain free from defects in material and workmanship including cracking, peeling, blistering and corroding for a period of three years from date of purchase.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of construction contiguous with bollards by field measurements.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
C. Steel Tubing: ASTM A 500, cold-formed steel tubing.

2.3 NONFERROUS METALS

A. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 (no salt areas) Type 316 (salt areas) stainless-steel fasteners. Select fasteners for type, grade, and class required.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Acrylic Primer: Thermoplastic acrylic primer compatible with topcoat.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Rust-Oleum Corporation; 3200 System Clear Blue Undercoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3,000 psi.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.7 FABRICATED METAL BOLLARDS

A. Fabricated Metal Bollard: Fabricate metal bollards from 1/4-inch wall-thickness round galvanized steel tubing.

1. Paint metal bollards with high performance coating primer and high performance paint finish coats. Refer to Section 09 96 00, “High Performance Coatings”.

2.8 BOLLARD COVERS

A. Plastic Bollard Cover: Heavy duty plastic bollard cover that fits over standard site-fabricated steel bollard.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Shield, Plastic Bollard Cover, ¼” thick polyethylene or comparable product.
2. Materials: 1/4” thick UV resistant and anti-static LDPE plastic sleeve, domed at top.
3. Sleeve for pipe diameter: 6 inch**.**
4. Color: Yellow. Color warrantied for five years.

2.9 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Finish metal fabrications after assembly.
C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.10 STEEL AND IRON FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Primer: Provide high performance shop primer in conformance with Section 09 96 00, “High Performance Coatings”.

D. Painting: Apply high performance coatings in conformance with Section 09 96 00, “High Performance Coatings”.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Coordinate location to avoid utilities.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

G. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 PRIMING AND PAINTING

A. Preparation for Shop Priming: Prepare surfaces in conformance with Section 09 96 00, “High Performance Coatings”.

B. Shop Priming: Apply high performance shop primer in conformance with Section 09 96 00, “High Performance Coatings”.

C. Painting: Apply high performance coatings in conformance with Section 09 96 00, “High Performance Coatings”. Provide the number of coatings (minimum) as specified.

3.3 INSTALLING FABRICATED METAL BOLLARDS

A. Fill bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards in place with concrete footings. Center and align bollards in holes 12 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured. Set bollard plumb.

3.4 INSTALLING PLASTIC BOLLARD COVERS

A. Install with manufacturer’s neoprene adhesive tape per manufacturer’s installation guidelines.

3.5 INSTALLING BOLLARD COVERS

A. Install bollard covers according to manufacturer's written instructions.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Provide touchup painting in conformance with Section 09 96 00, “High Performance Coatings”.
B. Clean all surfaces thoroughly and protect until acceptance.

END OF SECTION 32 50 00

SECTION 32 51 00 - METAL GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Swing gates.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

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

1. Primer.

B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Preinstallation Conference: Conduct conference at Project site.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
A. Steel Tubing: ASTM A 500, cold-formed steel tubing.
B. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304, Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Acrylic Primer: Thermoplastic acrylic primer compatible with topcoat.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Rust-Oleum Corporation; 3200 System Clear Blue Undercoat.

C. Concrete: Comply with requirements in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3,000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 SWING GATES

A. Gate Configuration: As indicated.
B. Gate Frame Height: As indicated.
C. Gate Opening Width: As indicated.
D. Cap exposed tubing ends with 1/4-inch-thick steel plate.
E. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf.
F. Prime gates with acrylic primer.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Finish metal fabrications after assembly.
C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Metal Gates: Shop prime with acrylic primer.

B. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.4 DEMONSTRATION

A. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 32 51 00

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.
3. Turf planting soil.
4. Turf planting soil amendments and fertilizers.
5. Turf renovation.
6. Turf
7. Turf maintenance.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including:

1. Seed.
2. Sod.
3. Fertilizer.
4. Compost.
5. Imported Topsoil.

B. Warranty: Sample of special warranty.

1.5 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

B. Qualification Data: For qualified landscape Installer.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Material Test Reports:

1. Imported Topsoil: Before delivery, submit written statement giving location of properties from which topsoil is to be obtained, names and addresses of property owners, analysis of topsoil, depth to be stripped, and any crops grown during the previous 5 years.

2. Compost: Before delivery, submit a recent US Composting Seal of Testing Assurance Program data sheet.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

B. Warranty: Executed special warranty.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Natural Turf Athletic Field Installer: Engage an experienced turf installation firm to perform athletic field work of this Section that has installed at least seven acceptable athletic fields of each of the types specified within past 5 years. Provide location and reference contacts for each of the submitted fields.]

2. Turf Installer: Engage an experienced turf installation firm to perform work of this Section that has installed at least seven (7) acceptable projects of the type specified within past 5 years. Provide location and reference contacts for each of the submitted projects.

3. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

4. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor with certifications outlined below on Project site when work is in progress.

5. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Certified Turfgrass Professional, designated CTP.
b. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; available nutrients; deleterious material; pH and recommendations to obtain optimal pH factor; mineral and plant-nutrient content of the soil; map with locations where each sample was collected; date, time and weather when samples were collected; and name of person who collected the samples.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

3. Report suitability of tested soil for turf growth.

a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1,000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.9 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 15 to May 15.
2. Fall Planting: August 15 to September 15.

B. Hydroseeding Restrictions: Do not hydroseed without prior written permission of the Architect.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.10 SEQUENCING AND REVIEW

A. Notify Architect no fewer than 48 hours in advance of proposed seeding and sodding to allow review of topsoil finish grading.

B. Do not proceed with seeding and sodding without Architect's written permission.

1. Architect’s written permission does not alleviate Contractor from conforming to the required grades indicated on Drawings.

1.11 MAINTENANCE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, as determined by the Architect, but for not less than the following periods:

1. Seeded and Sodded Turf: Five (5) documented mowings.

a. Document mowings in writing via fax or email to Owner and Architect on the day each mowing is performed. Failure of notification may subject Contractor to further mowings at no additional cost to Owner.

2. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Water: Provide all water required to properly irrigate temporary, permanent, and renovated turf areas. Include all facilities including, but not limited to, hoses, sprinklers, water cannons and reels, as long as it takes to establish and maintain turf. When adequate water supply or pressure is not available, supply water from offsite, including trucking.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace turf that fails in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.

2. Warranty Period:

a. Turf: 12 months, after acceptable turf is established, as determined by the Architect.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead turf and replace unless required to plant in the succeeding planting season.
b. Replace with seed or sod as originally specified.

B. Provide extended warranty for period equal to original warranty period, for replaced turf material.

PART 2 - PRODUCTS

2.1 SEED

A. Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Blends: Seed blend with not less than 95 percent germination, not less than 85 percent live seed, and not more than 0.5 percent weed seed.

1. If premixed blend, follow manufacturer’s recommended maximum seeding rate unless otherwise noted.

C. Lawn Seed:

1. Varieties: Premier varieties of Kentucky bluegrass, perennial ryegrass, tall fescue and fine fescue with a mean ranking of 6.0 or higher on the National Turfgrass Evaluation Program (NTEP) current list of tested varieties for the Northeast United States.

D. Seed Blends: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. General Lawn Mixture-Tall Fescue/Kentucky Bluegrass Blend: Proportioned by weight as follows:

   a. 85 percent tall fescue (Festuca arundinacea).
   b. 15 percent Kentucky bluegrass (Poa pratensis).

2. General Lawn Sun/Shade Mixture: Proportioned by weight as follows:

   a. 75 percent 1/3 equal mixture of three Kentucky bluegrass (Poa pratensis) varieties.
   b. 25 percent fine fescue (Fescue rubra).

3. Athletic Field Blend (Tall fescue/Kentucky Bluegrass): Proportioned by weight as follows:

   a. 75 percent tall fescue.
   b. 25 percent Kentucky Bluegrass

4. Conservation / Detention Basin Seed Blend: Provide native grass and forb seed mix containing the following varieties: Panicum clandestinum (Deertongue, “Tioga”); Carex vulpinoidea (Fox Sedge); Elymus virginicus (Virginia Wildrye); Panicum virgatum “Shawnee” (Switchgrass, “Shawnee”); Agrostis perennans (Autumn Bentgrass); Agrostis scabra (Rough Bentgrass); Juncus effuses (Soft Rush); Juncus tenuis (Path Rush); Scirpus atrovirens (Green Bulrush).

   a. Basis-of-Design Product: Subject to compliance with requirements, provide product manufactured by Ernst Conservation Seeds, Inc. “Native Detention Area Mix”, or comparable product.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Gold Tag certified premium quality seed, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Varieties: Premier varieties of Kentucky bluegrass and fescue with a mean ranking of 6.0 or higher on the National Turfgrass Evaluation Program (NTEP) current list of tested varieties for the Northeast United States.

C. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three varieties.
2. Sun and Partial Shade: Kentucky bluegrass (Poa pratensis) and fescue blend.

D. Moisture Content: Do not harvest or transplant sod when moisture content (excessively dry or wet) may adversely affect its survival.

E. Height: Mow sod before stripping to a height of one inch to 2-1/2 inches.

F. Thickness of Cut: Machine cut sod at a uniform soil thickness of 5/8-inch, plus or minus 1/4-inch, at time of cutting. Exclude top growth and thatch from measurement for thickness.

G. Pad Size: Cut to supplier's standard width and length. Maximum allowable deviation from standard widths of 1/2-inch. Maximum allowable deviation from standard length of 5 percent. Broken pads and torn or uneven ends not acceptable.

H. "Big Roll" Form: Sod cut a minimum 42 inches wide and 100 feet long, machine cut at uniform soil thickness of 0.75-inch, measured to exclude top growth and thatch.

I. Strength of Sod Sections: Standard size sections of strong strong enough to support own weight and retain size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

J. Thatch: Up to 1/2 inch height (uncompressed) allowable.

K. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CY Farms/Batavia Turf.
2. Lakeside Sod Supply Co., Inc.

2.3 INORGANIC SOIL AMENDMENTS

A. Perlite: Horticultural perlite, soil amendment grade.
B. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
C. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

2.4 ORGANIC COMPOST

A. Compost: Organic product manufactured through the controlled aerobic, biological decomposition of biodegradable materials which involves mesophilic and thermophilic temperatures to reduce weed seeds and stabilize carbon content. Manufacturing facility is to be registered and/or permitted by New York State Department of Environmental Conservation and is to comply with their requirements.

B. Compost requirements:

Parameters	Units of Measure	Range	Analysis Method
pH	pH units	5.8-7.8	TMECC 04.11-A
Soluble Salts Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 6	TMECC 04.10-A

Moisture Content	%, wet weight basis	20-50	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	Minimum 60	TMECC 05.07-A
Particle Size	% passing a selected mesh size, dry weight basis	97-100% Passing 3/8"	TMECC 02.02-B or ASTM D 2977
C:N Ratio	Ratio, dry weight basis	5:1 – 30:1	TMECC 05.02-A
Physical Contaminants (man-made inerts)	%, dry weight basis	<.50	TMECC 03.08

C. Mix with existing and imported topsoils in ratio designated in "Turf Planting Soil" Article below. Compost must be provided for both existing and imported topsoil, with the exception of topsoil with 10% of organic content and above.

D. Compost testing is to be in accordance with the US Composting Seal of Testing Assurance Program.

E. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following or a comparable product:

1. Naturcycle Compost, Naturcycle LLC
2. WeCare Compost, WeCare Organics
3. Sustane Concentrated Compost 2-6-3, Sustane Natural Fertilizer, Inc.
4. Agresource, Inc. - Agresoil Compost

2.5 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition, unless otherwise indicated:

1. Spring Fertilization: 10 percent nitrogen, 6 percent available phosphorous, and 4 percent water-soluble potash (10-6-4).

2. Fall Fertilization: 5 percent nitrogen, 10 percent available phosphorous, and 5 percent water-soluble potash (5-10-5).

3. Final Fertilization:

   a. Spring: Granular slow release fertilizer with high nitrogen (38 percent), Uramite or other Architect-approved material.

b. Fall: “Fall Fertilization” composition above.

4. Follow requirements regarding fertilization recommended in soil reports from a qualified soil-testing laboratory.

2.6 TURF PLANTING SOILS

A. General: Provide turf planting soil consisting of existing and/or imported topsoil with amendments and fertilizers noted in this Section. Unamended existing or imported topsoil is not acceptable as turf planting soil.

1. Where quantities of existing topsoil are insufficient to provide 6 inch depth turf planting soil, supplement with imported topsoil, at no additional cost to Owner.

B. Topsoil Requirements: Free of subsoil, stones 1 inch or larger in any dimension, dense material, hardpan, slag, clay, cinders, sod, roots, sticks, poison ivy, crabgrass, cough grass, noxious weeds, and foreign matter, including but not limited to glass, screws, asbestos, toxins, hazardous wastes, petroleum product contamination, lead and chemicals (such as atrizene and muriatic acid) that may be injurious to humans, animals and plant materials.

1. Mechanically screen topsoil to conform to following gradations:

Sieve Designation	Percent Passing
1 inch	100
1/4 inch	97-100
#200	20-65 of the 1/4-inch sieve

2. No more than 60 percent of material passing #100 mesh shall consist of clay as determined by Bouyoucous hydrometer or by decantation method.

3. Topsoil to comply with the following:

a. Organic Matter Content: Not more than 10 percent.
b. Corrected to pH Value: 6.5 to 7.5 on that portion passing 1/4-inch sieve.
c. Soluble Salt Content: Not to exceed 500 parts per million.

C. Existing Topsoil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil.

1. Provide soil analysis per requirements in Part 1 of this Section.

D. Imported Topsoil: Imported topsoil obtained from local sources or from areas having similar soil characteristics as Project site. Obtain topsoil displaced from naturally well-drained sites where topsoil occurs at least 6 inches deep; do not obtain from agricultural land, bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2. Provide soil analysis per requirements in Part 1 of this Section.

E. Required Amendments: Mix existing and imported topsoil with the following soil amendments in the following quantities to produce planting soil:

1. Organic Compost:

a. Ratio of Loose Compost to Blended Topsoil: For bidding purposes, provide 1 part compost to 5 parts blended topsoil, or in quantity great enough to achieve 8% organics based on top soil testing report

b. Regardless of topsoil organic content, add organic compost to all turf planting soils, including topsoils placed on slopes and in stormwater basins, swales and biofiltration areas.

2. pH Adjustment: Apply approved calcium or sulfur compounds to correct pH level to be between 6.5 and 7.5 or as recommended by soil analysis report.

3. Soil Analysis Recommendations: Provide nutritional and other amendments recommended in the soil analysis report, as approved by Architect.

4. Provide fertilizer per “Fertilizer” Article above.

2.7 TOPDRESSING SAND

A. Provide processed sand tested to meet the following requirements per ASTM-F-1632.

B. Processed Sand: The sand shall meet the following particle size criteria:

	Sieve Mesh	Diameter of Sieve (mm)	Allowable Range % retained
Coarse Gravel	5	4.00	0%
Fine Gravel	10	2.00	0-5%
Very Coarse Sand	18	1.00	0-20% combined with gravel
Coarse	35	0.50	20-50%
Medium	60	0.25	20-40%
Fine	100	0.15	20% maximum
Very Fine	270	0.50	5% maximum
Silt & Clay			3% maximum

1. Sand is to have a coefficient of uniformity not exceeding 3.5 (D60/D10).
2. Maximum of 5% combined very fine sand, silt and clay allowable.
3. Minimum of 60% in the medium and coarse size fractions required.

2.8 BIORETENTION PLANTING SOIL

A. Bioretention Planting Soil: Screened, natural, fertile, sandy loam or loamy sand per USDA standards capable of sustaining vigorous plant growth, from well drained site free of flooding, not in frozen or muddy condition, not less than 3 percent organic matter, and pH value of 5.9 to 7.0. Free from subsoil, slag, clay, stones, lumps, live plants, roots, sticks, crabgrass, coughgrass, noxious weeds, and foreign matter. Comply with the following requirements:

Item	Percent By Weight	Test Method
Sand (2.0 – 0.050 mm)	40 – 85	AASHTO T88
Silt (0.050 – 0.002 mm)	20 – 50	AASHTO T88
Clay (less than 0.002 mm)	10 – 20	AASHTO T88
Organic Matter	1.5 – 10	AASHTO T194

ASTM E11 Sieve Size	Min. Percent Passing by Weight
2 inch	100
No. 4	90
No. 10	80

Item	Criteria	Test Method
Corrected pH	5.5 – 7.5	ASTM D4972
Magnesium	Minimum 32 ppm	
Phosphorus (Phosphate - P_2O_5)	Not to exceed 69 ppm	
Potassium (K_2O)	Minimum 78 ppm	

2.9 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.10 EROSION-CONTROL MATERIALS

A. Refer to Section 31 25 00 “Erosion and Sedimentation Controls.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Bulk-mix screened topsoil, soil amendments, organic compost and fertilizer, and thoroughly blend planting soil.

1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
2. If soil testing recommendations do not provide fertilizer application quantities, provide application rate of 1 lb. of nitrogen per 1,000 square feet.
3. If liming is required, mix lime with dry soil before mixing fertilizer.

D. If topsoil is to remain in place, thoroughly incorporate the additives into the top 6 inches of topsoil.

E. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

1. Spread approximately 1/3 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
2. Reduce elevation of planting soil to allow for soil thickness of sod.

F. Unchanged Subgrades: If topsoil is to remain in place, prepare surface soil as follows:

1. Cut neat line between existing turf to remain and new turf.

2. Remove existing grass, vegetation, and turf. Do not mix into surface soil.

3. Loosen surface soil to a depth of at least 6 inches. Uniformly apply the soil amendments, organic compost and fertilizer over the entire area using a compost spreader or similar equipment that will achieve a uniform application, according to planting soil mix proportions and mix thoroughly into top 5 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

4. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.

5. Legally dispose of waste material, including grass, vegetation, and turf.

G. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

H. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

I. Before planting, obtain Architect's written permission; restore planting areas if topsoil finish grading is eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Erosion Control Matting: Install amended topsoil and seed before erosion control matting is installed. Follow manufacturer's installation recommendations.

B. Turf reinforcement matting: Install planting soil in two lifts. First lift is installed before the matting is placed. Second lift is placed after the matting is installed by filling the cells of the matting with planting soil. Lightly compact soil before seeding. Follow manufacturer's installation recommendations.

3.5 SEEDING

A. Timing: Provide seeding within planting times indicated.

1. Seed at earliest possible date to achieve mature turf prior to Owner occupancy.
2. Sow Tall Fescue varieties preferably in fall.

B. Sow seed with Brillion spreader or similar seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in three passes: second pass at 90 degrees to the first, third pass at 45 degrees to second.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

C. Sow seed at a total rate of 6 lb/1,000 sq. ft.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

E. Protect seeded areas with slopes not exceeding 1:4 as follows:

1. In small areas adjacent to buildings, at parking islands and narrow strips of seeding along paving, spread straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment. Avoid areas of thick mulch that will prevent seed determination.

2. In larger areas, including athletic fields if approved by Architect, mulch by hydromulching.

F. Water newly planted areas and keep moist until new turf is established.

3.6 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

D. Water newly sodded areas and keep moist until new turf is established.

3.7 EXISTING TURF RENOVATION/REPAIR – GENERAL (NON-ATHLETIC FIELD) AREAS

A. Renovate existing turf indicated on Drawings, turf areas disturbed as part of Project, and areas damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles. Reestablish turf where settlement or washouts occur or where minor regrading is required and install new planting soil and turf as required below.

1. In areas where turf has been removed, killed, damaged or contaminated:

a. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

b. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

c. Till stripped or bare areas thoroughly to a soil depth of 4 inches.

d. Install new planting soil to fill low spots and meet finish grades.

e. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of soil.

f. Apply seed and protect with straw mulch as required for new turf.

g. Water newly planted areas and keep moist until new turf is established.

h. For other maintenance required, refer to Turf Maintenance section.

2. In areas where existing turf remains:

a. Mow to height of 2-1/2".
b. Core aerate in two to three passes at a rate of nine holes minimum per square foot to a minimum depth of 4 inches, and rake existing turf.
c. Remove weeds.
d. Remove waste and foreign materials, loose vegetation, and legally dispose of them off Owner's property.
e. Drag to break up cores or remove them.
f. Topdress with fine topsoil and overseed if there is less than 90% healthy turf coverage.

3.8 EXISTING TURF RENOVATION/REPAIR – ATHLETIC FIELD AREAS

A. Renovate existing athletic field turf indicated on Drawings or athletic field turf areas disturbed as part of Project as required below:

1. Determine areas that are too high and low to drain properly or that affect playability. Remove sod from those areas and shave down high spots and fill in low spots.

2. Install new planting soil to fill low spots.

3. Remove weeds.

4. Mow to height of 2-1/2".

5. Core aerate with an aerator equipped with ¾" spoons in two to three passes at a rate of thirty holes minimum per square foot to a minimum depth of 4 inches.

6. Apply 50/50 mixture of Topdressing Sand and finely screened or granular Organic Compost (3/8" minus or less) evenly over turf surface using a top dresser or other suitable equipment in a uniform depth of ½".

7. Break up cores and smooth grade with a York rake, weighted chain link fence fabric or other acceptable equipment.

8. Apply seed to bare areas and areas with thin turf coverage per seeding specification.

9. Work should be done in late spring or early fall.

3.9 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Use hand weeding to control weeds. Schedule weedings throughout the year to maintain turf as free of weeds as possible.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf when new growth reaches 3.75-4.5 inches in height. Repeat mowing to maintain specified height once per week or as needed to ensure the maximum height does not exceed 4.5 inches between mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow turf to a height of 2-1/2 to 3 inches.
2. Neatly trim edges and hand clip where necessary.
3. Immediately after each mowing (same day), carefully remove excess clippings to prevent damage to turf.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

3.10 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, brown spots, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

C. Warranty period does not begin until satisfactory turf is established, as determined by the Architect.

3.11 CONSERVATION GRASSES

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate recommended by manufacturer and approved by Architect.

C. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.

D. Mulch in accordance with manufacturer's recommendations.

E. Water newly planted areas and keep moist until meadow is established.

3.12 CONSERVATION GRASSES MAINTENANCE

A. Maintain and establish conservation grasses by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable grasses. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

B. Watering: Install and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep planting uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water planting with fine spray at a minimum rate of 1/2 inch per week for eight weeks after planting unless rainfall precipitation is adequate.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.
4. Mulch.
5. Landscape edging.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

I. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Manufactured topsoil that is modified with soil amendments and fertilizers to produce a soil mixture best for plant growth.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

Q. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

B. Warranty: Sample of special warranty.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Material Test Reports**:**

1. For existing native surface topsoil and imported topsoil.

C. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

1.7 CLOSEOUT SUBMITTALS

A. Warranty: Executed special warranty.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Five (5) years of experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor shall have certification in the following categories from the Professional Landcare Network:

a. Certified Landscape Technician - Exterior, with installation and maintenance areas, designated CLT-Exterior.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

3. Report suitability of tested soil for plant growth.

   a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

   b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

F. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.

2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others.

C. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion. Adjust planting period for plant species that require a specific planting period per industry standards.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.
c. Faulty performance of tree stabilization and/or other landscaping products provided.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of written acceptance of planting by Architect:

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
d. Replace plants with material of the same species, quantity and size unless a substitution is approved by the Architect.
e. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.12 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees, Shrubs, Ground Covers and other plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 12 months from date of written acceptance of planting by Architect.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature from “Standardized Plant Names” listing by American Joint Committee of Horticulture for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2. Provide lime in form of ground dolomitic limestone if additional magnesium is determined by soil testing to be required; provide calcitic limestone or mollusk shells if additional magnesium is not required.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-decomposed, stable, and weed-free organic matter derived from agricultural, food, or industrial residuals; biosolids; animal manures; yard trimmings; or source-separated or compostable mixed solid waste, meeting the following requirements:

Parameters	Units of Measure	Range	Analysis Method
pH	pH units	5.8-7.8	TMECC 04.11-A
Soluble Salts Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 7	TMECC 04.10-A
Moisture Content	%, wet weight basis	20-45	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	40-90	TMECC 05.07-A
Particle Size	% passing a selected mesh size, dry weight basis	97-100% Passing 3/8”	TMECC 02.02-B or ASTM D 2977
C:N Ratio	Ratio, dry weight basis	5:1 – 30:1	TMECC 05.02-A
Physical Contaminants (man-made inerts)	%, dry weight basis	<1	TMECC 03.08

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Sustane 2-6-3 Concentrated Compost, Sustane Natural Fertilizer, Inc.

b. WeCare Compost, manufactured by WeCare Organics, LLC; www.wecareorganics.com.
c. Agresoil Compost, manufactured by Agresource, Inc; www.agresourceinc.com

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight or as recommended in soil-testing reports.

C. Chelated Iron: If recommended in soil-testing report, provide commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

2.5 PLANTING SOILS

A. Native Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Supplement with imported planting soil when quantities are insufficient.

2. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

a. Compost: Ratio of loose compost to topsoil by volume: 1:4. Compost is required to be added to planting topsoil regardless of organic content of topsoil.
b. Weight of Commercial Fertilizer per 1,000 Sq. Ft.: 1 lb.
c. Weight of Lime per 1,000 Sq. Ft.: To be determined by pH and nutritional testing of soils provided by Contractor..
d. Weight of Sulfur per 1,000 Sq. Ft.: To be determined by pH and nutritional testing of soils provided by Contractor. Will be furnished by Owner.

B. Imported Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. For quantity of soil amendments and fertilizers, see requirements for Native Topsoil above, including compost and commercial fertilizer.

2. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.6 MULCHES

A. Shredded Hardwood Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs complying with requirements below. Shredded former wood products are not allowed (ex., wood pallets).

1. Type: Shredded hardwood
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural (no added color).

2.7 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or softwood with specified wood pressure-preservative treatment, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.

2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes, turnbuckles or compression springs.

3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.

2.9 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Edging Size: 3/16 inch wide by 4 inches deep.

2. Stakes: Tapered steel, a minimum of 15 inches long.

3. Accessories: Standard tapered ends, corners, and splicers.

4. Finish: Zinc coated.

5. Basis-of-Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Border Concepts, Inc.
   b. Collier Metal Specialties, Inc.
   c. Russell, J. D. Company (The).
   d. Sure-Loc Edging Corporation.

6. Color: Black.

2.10 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Stake locations of individual tree and shrub locations and areas for multiple plantings. Notify architect a minimum of one week prior to planting. Staked location to be approved by architect prior to installation, excavation of pits or preparation of beds. Make minor adjustments as required.

D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. If liming is required, mix lime with dry soil before mixing fertilizer.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.

2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.

4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.

5. Maintain supervision of excavations during working hours.

6. Keep excavations covered or otherwise protected at all times.

B. Subsoil removed from excavations may not be used as planting soil.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting soil for backfill.

2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting soil for backfill.

2. Carefully remove root ball from container without damaging root ball or plant.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Set and support bare-root stock in center of planting pit or trench with root flare 1 inch above adjacent finish grade.

1. Use planting soil for backfill.

2. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.

3. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.

4. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

C. Cut exposed roots cleanly during transplanting operations.

D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

E. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

B. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Install trunk stabilization only when trees are subjected to windy or other conditions that increases the likelihood of tipping or leaning:

1. Upright Staking and Tying:

a. For trees of 2-inch through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Refer to Drawings for trunk stabilization requirements. Allow enough slack to avoid rigid restraint of tree or support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

2. Staking and Guying: Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated. Securely attach no fewer than three guys to stakes 30 inches long, driven to grade.

   a. Site-Fabricated Staking-and-Guying Method: For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle or compression spring for each guy wire and tighten securely. Support trees with one of two systems below:

      1) Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.

      2) Support trees with strands of cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.

      3) Paint turnbuckles and compression springs with luminescent white paint.

3.9 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

   1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring with radius as indicated in planting details around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

   2. Mineral Mulch in Planting Areas: Apply mineral mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 6 inches of trunks or stems.

3.10 EDGING INSTALLATION

A. Aluminum Edging: Install edging where indicated according to manufacturer's written instructions. Anchor with manufacturer-provided stakes spaced per manufacturer’s instructions, driven below top elevation of edging.

B. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with manufacturer-provided steel stakes spaced per manufacturer’s instructions, driven below top elevation of edging.

C. Plastic Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches apart, driven through upper base grooves or V-lip of edging.

D. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4-inch to 6-inch- deep, shovel-cut edge as shown on Drawings.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to avoid the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance period. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, nursery stakes, tie tape, wire, burlap, and other debris from plant material, planting areas, and Project site.

1. Nursery tags to be removed only after Architect’s Substantial Completion review of plant materials.

3.13 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 32 93 00

SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Non-pressure transition couplings.
3. Pressure pipe couplings.
4. Perforated Edge Drains.
5. Cleanouts.
6. Drains.
7. Frames and grates/lids
8. Channel drainage systems.
9. Catch basins.
10. Stormwater Manholes.
11. Dry wells.
12. Stormwater Outlet structures.
13. Pipe outlets.
14. Stormwater disposal systems.
15. Flared End Sections

B. Related Sections:

1. Section 01 78 39 “Project Record Documents”
2. Section 31 20 00 "Earth Moving"

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Stormwater Manholes: Include plans, elevations, sections, details, frames, covers, and grates.
2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.
3. Outlet Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer (where applicable) indicating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Perform work, including shoring, in compliance with the applicable requirements of governing authorities having jurisdiction.

B. Comply with applicable Utility Company Regulations. Municipal Sewer Connection: Coordinate connection to existing municipal sewer with local sewer authority. Pay for all fees associated with connection to municipal sewer.

1. Local sewer authority contact:

Town of Wallkill
Department of Public Works
99 Tower Drive, Bldg A
Middletown, NY 10941
Telephone: 845-326-1435
Fax: 845-692-2546

2. Install connections to municipal sewer in accordance with local sewer authority standards and OSHA regulations. Provide materials complying with local sewer authority standards.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
B. Protect pipe, pipe fittings, and seals from dirt and damage.
C. Handle stormwater manholes according to manufacturer's written rigging instructions.
D. Handle catch basins according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SOLID DOUBLE WALL HDPE SMOOTH INTERIOR PIPE:

A. Interior Diameter, 4" to 36": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:

1. Applicable Standards:

a. 4 inch to 10 inch pipe: AASHTO M 252-Type S or SP
b. 12 inch to 36 inch pipe: AASHTO M294-Type S or SP

2. Mannings “n” Value: 0.012.

3. ASTM D3034 for maximum allowable deflection.

4. Fittings: Meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.

5. Manufacturer: Similar to "N-12 Smooth Interior Pipe” by Advanced Drainage Systems, Inc.; London, Ohio.

B. Interior Diameter, 42" to 60": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:

1. Applicable Standards

a. 42 inch to 48 inch pipe: AASHTO MP6
b. 60 inch pipe: AASHTO MP7

2. Mannings “n” Value: 0.012.

3. ASTM D3034 for maximum allowable deflection.

4. Fittings to meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.

5. Manufacturer: Similar to "N-12 HC High Capacity Large Diameter Pipe” by Advanced Drainage Systems, Inc.; London, Ohio.

C. Interior Diameter, 4" to 30": Corrugated polyethylene circular pipe with silt-tight joints and an integrally formed smooth interior complying with the following specifications:

1. Applicable Standards

   a. 4 inch to 10 inch pipe: AASHTO M 252-Type S or SP
   b. 12 inch to 36 inch pipe: AASHTO M 294-Type S or SP

2. Mannings “n” Value: 0.010.

3. Fitttings: AASHTO M252 or M294.

4. Joints: Meeting AASHTO Standard Specification for Highway Bridges, Section 26 paragraph 26.4.2.4(e). Silt tight – meeting ASTM D1056 Grade 2A2.

5. Materials: ASTM 3350 minimum cell classification 324420C (4" to 10") or 335420C (12" to 30").

6. Similar to “Hi-Q Pipe” by Hancor, Inc.; Findlay, Ohio.

D. Interior Diameter, 36" to 60": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:

1. Applicable Standard: AASHTO M 294-Type S or SP
2. Mannings “n” Value: .010.
3. Fitttings: AASHTO M294.
4. Joints: “Sure-Lok” joints meeting AASHTO M294.
5. Materials: ASTM 3350 minimum cell classification 335420C.
6. Similar to “Sure-Lok F477 Pipe” by Hancor, Inc.; Findlay, Ohio.

2.2 PERFORATED SINGLE WALL HDPE CORRUGATED PIPE:

A. Interior Diameter, 3" to 24": Corrugated perforated single wall polyethylene circular pipe with uniform slots and drilled holes complying with the following specifications:

1. Applicable Standards:

   a. 3 inch to 10 inch pipe: AASHTO M 252
   b. 12 inch to 24 inch pipe: AASHTO M294

2. Fittings: Meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.

3. Manufacturer: Similar to “Perforated Single Wall Plastic Corrugated Pipe” by Advanced Drainage Systems, Inc.; London, Ohio.

2.3 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe, green in color, with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Pressure Piping:

1. Pipe: AWWA C900, Class 150 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 150 PVC pipe with bell ends
3. Gaskets: ASTM F 477, elastomeric seals.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Charlotte Pipe and Foundry
2. J-M Manufacturing
3. IPEX Inc.

2.4 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dallas Specialty & Mfg. Co.
   b. Fernco Inc.
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. NDS Inc.
   e. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

2. Description: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.5 PRESSURE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cascade Waterworks Mfg.
2. Dresser, Inc.
3. Ford Meter Box Company, Inc. (The); Pipe Products Div.

B. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.

C. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 200-psig minimum pressure rating and ends sized to fit adjoining pipes.

D. Center-Sleeve Material: Manufacturer's standard.

E. Gasket Material: Natural or synthetic rubber.

F. Metal Component Finish: Corrosion-resistant coating or material.

2.6 PERFORATED EDGE DRAINS

A. Perforated Edge Drain Piping: 1" x 12" polyethylene multi-channeled edge drain with polypropylene filter fabric sock. Provide all fittings and connections required for installation fabricated by manufacturer of drainage piping used. Similar to “AdvanEdge Pipe” by Advanced Drainage Systems.

1. Pipe Properties

a. Compressive Strength (ASTM D-695):..... 6,000 psf (41.7 psi) minimum.
b. Flow Rate (ASTM D-4716): ..... 11gpm/sf.
c. Peel Strength (ASTM D-1876):..... 35 lbs/ft minimum.
d. Core Thickness:..... 0.80"

2. Drainage Fabric Properties

a. Grab Tensile Strength (D-4632):..... 120 lbs.
b. Grab Elongation Strength (ASTM D-4632):... 60%.
c. Mullen Burst Strength (ASTM 3786): ..... 90 psi.
d. Puncture Strength (ASTM 4833): ..... 30 lbs.
e. Trapezoid Tear Strength (ASTM D-4533):..... 40 lbs.
f. U.V. Resistence (ASTM D-4355):..... 70% strength retained.
g. A.O.S.:..... Per ASTM D-4751
h. Permeability (ASTM 4491):..... K Fabric > K Soil
i. Permitivity (ASTM 4491): 7

2.7 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover with vandal proof screws. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

3. Top-Loading Classification(s): Heavy Duty.

4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. NDS Inc.
    b. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
    c. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.8 DRAINS

A. Inline Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Nyloplast by Advance Drainage Systems, Inc.

2. Description: Precast PVC Inlet with cast or ductile iron body with anchor flange and round grate in diameter shown on Drawings. Include watertight pipe adapters of sizes indicated.

a. Joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals

b. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron and ASTM A-48-83 class 30B for 12" and 15" cast iron frames. Grates shall be provided painted black

3. Backfill Material

a. The backfill material shall be crushed stone or other granular material meeting the requirements of Structure Bedding as defined in Section 31 20 00 Earth Moving.
b. The drainage inlets shall be bedded and back-filled uniformly in accordance with ASTM D2321.

4. Top-Loading Classification(s): Heavy Duty H20 Traffic Loading.

2.9 FLARED END SECTIONS

A. Galvanized Steel End Sections: Flared end sections manufactured in accordance with New York State Department of Transportation Standard Specification, Item 707-10.

2.10 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3,000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.11 CHANNEL DRAINAGE SYSTEMS

A. Channel Drain System "4-in WIDE WAVE GRATE"

1. General Requirements Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Equivalent to "KS100 KlassikDrain" by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com; or equal:

   a. ABT, Inc.
   b. Poly-Cast.

3. Sloped-Invert, Polymer-Concrete Systems:

   a. Trench Drain Channel Sections:

      1) Compressive Strength: 14,000 P.S.I.
      2) Flexural Strength: 4,000 P.S.I.
      3) Water Absorption Rate: 0.07%
      4) Edge Rail: Stainless Steel
      5) Edge Rail thickness: 3/32-in min.
      6) Wall thickness: 0.50-in min.
      7) Internal slope: 0.5%
      8) Unit Width: 5.12-in
      9) Internal Width: 4.00-in
      10) Unit invert depth: (Varies) 4.13-in to 11.81-in
      11) Unit length: 39.37-in (1-Meter)
      12) Partial radius trench bottom.
      13) Interlocking-joint, precast, modular units with end caps.

   b. Trench Drain Grates "4-in WIDE WAVE GRATE":

      1) Resin composite grate, equivalent to "ACO Type 480D Iron Wave" grate by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com

      2) Certified to EN 1433 Load Class C (56,000 lbs – 1,162 psi)

      3) Material: Ductile iron to ASTM A 536-84, Grade 65-45-12

      4) Size: 4.84-in Width by 19.69-in Length each unit.

      5) Slots to measure at 0.27-in by 2.4-in.

      6) "DrainLok" or equivalent boltless locking system

      7) Intake area of 27.0 sq. in per half meter of grate

      8) E-Coated for improved rust resistance

      9) Complies with ADA – American Disability Act of 1990 Section 4.5.4

      10) Bicycle Tire Penetration Resistance to AS 3996-2006.

4. Drainage Specialties: Precast, polymer-concrete units.

   a. Catch Basins:

      1) To suite KS100 Channel Drain
      2) Type “K1-901S” In-Line Catch Basin
      3) 19.69-in to 22.67-in by approximately 10.06-in polymer-concrete body, with outlets in quantities and sizes indicated.
      4) Grate: ACO Type 480D Iron Wave.

5. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.12 CHANNEL DRAINAGE SYSTEMS

A. Channel Drainage Systems “8-in WIDE WAVE GRATE”

1. Trench Drain (Sloped-Invert, Polymer–Concrete System): Precast polyester or vinyl ester resin, interlocking channel unit, with built-in 0.5% slope and recesses for lock down devices, and stainless steel edge rail. Equivalent to “KS200 KlassikDrain” by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com

   a. Trench drain channel:

      1) Compressive Strength: 14,000 P.S.I.
      2) Flexural Strength: 4,000 P.S.I.
      3) Water Absorption Rate: 0.07%
      4) Edge Rail thickness: 3/32-in min.
      5) Wall thickness: 0.50-in min.
      6) Internal slope: 0.5%
      7) Unit Width: 10.24-in
      8) Internal Width: 8.00-in
      9) Unit invert depth: (Varies) 7.87-in to 15.75-in
      10) Unit length: 39.37-in (1-Meter)
      11) Full radius trench bottom.
      12) Frost proof, salt proof, dilute acid and alkali resistant.

   b. Trench drain catch basins: Equivalent to ACO “K2-621S” precast polymer concrete catch basin, with integral plastic PVC trash bucket with removable grating.

      1) Compressive Strength: 14,000 P.S.I.
      2) Flexural Strength: 4,000 P.S.I.
      3) Material: Cast in stainless steel frame with polyester polymer concrete top unit body

4) Water Absorption Rate: 0.07% by weight
5) Edge Rail thickness: 1/8-in min.
6) Wall thickness: 0.59-in min.
7) Unit Width: 14.25-in
8) Unit Depth: 37.64-in
9) Unit length: 19.69-in (0.5-Meter)
10) Frost proof, salt proof, dilute acid and alkali resistant.

c. Trench drain grates: Resin composite grate, equivalent to "ACO Type 680Q Iron Wave" grate by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com

1) Independently certified to meet Load Class C to EN 1433 – 56,000 lbs – 1,162 psi
2) Material: Ductile iron to ASTM A 536-84, Grade 65-45-12
3) Size: 9.41-in Width by 19.69-in Length each unit, 1.18-in thick. Slots to measure at a maximum of 0.43-in.
4) "QuicklLok" or equivalent boltless locking system
5) Intake area of 58.72 sq. in per half meter of grate
6) E-Coated for improved rust resistance
7) AMA – American Disabilities Act of 1990 Section 4.5.4 Compliance
8) Bicycle tire penetration resistance to AS 3996-2006

2.13 CHANNEL DRAINAGE SYSTEMS

A. General Requirements Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABT, Inc.
2. ACO USA.
3. Poly-Cast.

C. Sloped-Invert, Polymer-Concrete Systems:

1. Channel Sections:

a. Interlocking-joint, precast, modular units with end caps.
b. 4-inch inside width and deep, rounded bottom, with built-in invert slope of 0.6 percent and with outlets in quantities, sizes, and locations indicated.
c. Extension sections necessary for required depth.
d. Frame: Include gray-iron or steel frame for grate.

2. Grates:

   a. Manufacturer's designation "Heavy Duty," with slots or perforations that fit recesses in channels.
   b. Material: Gray iron.
   c. Grating must meet ADA requirements in Pedestrian areas.

3. Covers: Solid gray iron if indicated.

4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

D. Drainage Specialties: Precast, polymer-concrete units.

1. Catch Basins:

   a. 19-inch to 24-inch by approximately 6-inch polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate.
   c. Frame: Include gray-iron or steel frame for grate.

E. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

F. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.14 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening.
B. Gutter Inlets: Made with horizontal gutter opening. Include heavy-duty frames and grates.
C. Combination Inlets: Made with vertical curb and horizontal gutter openings. Include heavy-duty frames and grates.

2.15 CATCH BASINS

A. Inside Dimension: Round 48-inch diameter minimum clear inside dimension, unless otherwise indicated.

B. Description: ASTM C 913, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

C. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

D. Riser Sections: 4-inch minimum thickness, Length, Width and Depth as indicated.

E. Top Section: Flat-slab-top type is indicated.

F. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

G. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

H. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match the frame and grate, and height as required to adjust manhole frame and cover to indicated elevation and slope.

I. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.16 CATCH BASIN FRAMES AND GRATES

A. Heavy Duty Ductile Iron Frame and Grate:

1. Description: Heavy-duty 24-in by 24-in (nominal clear opening) ductile iron frame and grate.

2. Material Requirements:

a. Material: ASTM A 536, Grade 70-50-05, ductile iron designed for A-16, structural loading. Meets AASHTO M306
b. Grate style: Bar, Flat
c. Frame style: Top Flange, Reversible, Bottom Flange
d. Coating: Asphaltic Coated
e. Color: Black
f. Origin of manufacture: USA
g. Clear opening depth: 24-in minimum, unless otherwise indicated
h. Clear opening length: 24-in minimum, unless otherwise indicated
i. Cover/Grate opening depth: 2-in
j. Cover/Grate opening width: 26-in
k. Cover/Grate opening length: 26in
l. Flange inner length: 26-in
m. Flange inner width: 26-in
n. Flange outer length: 32-in
o. Flange outer width: 32-in
p. Frame height: 6-in
q. Frame outside length: 27.5-in
r. Frame outside width: 27.5-in
s. Grate thickness: 2-in
t. Grate length: 25.75-in
u. Grate width: 27.75-in
v. Grate open area: 321 sq. in.
w. Grate wetted perimeter: 103-in
x. Slot width: 1.5-in
y. Tag Text: “Drains To Waterways Dump No Waste!”

3. Basis-of-Design Product: Subject to compliance with requirements, provide EJ Group Inc., Product No. 45726033C03 – “Classic Series V5626-2 REV 6” V5726 EXHD DI GR SET” by EJ Group Inc. (East Jordan Iron Works), 301 Spring Street, East Jordan, MI 49727 Telephone: 1-800-874-4100.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7 to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.17 DRY WELLS

A. Description: ASTM C 913, precast, reinforced, perforated concrete rings. Include the following:

1. Floor: Cast-in-place concrete.

2. Cover: Liftoff-type concrete cover with cast-in lift rings.

3. Wall Thickness: 4 inches minimum with 1-inch diameter or 1-by-3-inch- maximum slotted perforations arranged in rows parallel to axis of ring.

a. Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
b. Ring Construction: Designed to be self-aligning.

4. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.

2.18 STORMWATER MANHOLE

A. Standard Precast Concrete Stormwater Manholes:

1. Diameter: 48 inches minimum unless otherwise indicated.

2. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

4. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.

5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

7. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

8. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and grate, and height as required to adjust manhole frame and cover to indicated elevation and slope.

9. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.

10. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.

11. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.19 STORMWATER MANHOLES / DRYWELL – FRAMES AND GRATES / COVERS

A. Frames and Grates (Open Grates):

1. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and grates and fabricate round frames and grates in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit.

2. Frame and Grate

   a. Material: Class 35B Cast Iron
   b. Loading Requirements: AASHTO M306 (Meets or Exceeds H20 Loading)
   c. Coating: Shop Dipped Black Asphaltum.

3. Frame:

   a. Frame Depth: 7-inches
   b. Clear open width: 24 inches
   c. Overall frame width: 36 inches diameter

4. Grate – Non-ADA Flat Grate:

   a. 26 inch open diameter
   b. Grate Open Area: 190 square inches
   c. Lettering: “Dump No Waste”

5. Grate – ADA Flat Grate:

   a. 26 inch open diameter
   b. Grate Open Area: 130 square inches
   c. Lettering: “Dump No Waste”

6. Basis of Design: Similar to Frame “Model #1045 (#00104510) and Grate “Type M3 ADA Grate” (#00104036) by East Jordan Iron Works, Inc.

7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Neenah Foundry Co.
   b. East Jordan Iron Works, Inc (EJ Group, Inc.)
   c. Campbell Foundry
   d. General Foundries

B. Frames and Covers (Solid Cover):

1. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and covers and fabricate round frames and covers in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit. Apply shop coat of asphaltum to all units.

2. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

3. Material: Heavy Duty Round Frame and Covers, weight at least 350 lbs, meeting ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Neenah Foundry Co.
   b. East Jordan Iron Works, Inc (EJ Group, Inc.)
   c. Campbell Foundry
   d. General Foundries

2.20 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Basis-of-Design Product: Subject to compliance with requirements, provide StormTech LLC or comparable product by one of the following:

   a. Advanced Drainage Systems.
   b. CULTEC, Inc.
   c. Hancor Inc.
   d. Infiltrator Systems, Inc.

2. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.

3. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.

4. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd.

B. Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252M for NPS 10 and smaller, AASHTO M 294M for NPS 12 to NPS 60. Include proprietary fittings, couplings, seals, and filter fabric.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Advanced Drainage Systems or comparable product by one of the following:

a. Hancor Inc.

2.21 STORMWATER TREATMENT DEVICES

A. Materials and Design

1. Precast concrete components shall conform to applicable sections of ASTM C 478, ASTM C 857 and ASTM C 858 and the following:

a. Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);

b. Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;

c. Cement shall be Type III Portland Cement conforming to ASTM C 150;

d. Aggregates shall conform to ASTM C 33;

e. Reinforcing steel shall be deformed billet-steel bars, welded steel wire or deformed welded steel wire conforming to ASTM A 615, A 185 or A 497, respectively;

f. Joints shall be sealed with preformed joint sealing compound conforming to ASTM C 990 and

g. Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.

2. Internal Components shall conform to the following:

a. The internal components shall include the center shaft and cone, dip plate, benching skirt, floatables lid, and component support frame.

1) Materials of construction for the above components shall be cross-linked polyethylene (XLPE). The component support frame members and all metal parts shall be Type 304 stainless steel. All components shall be designed to withstand all normal loading associated with fabrication, shipping, site installation, and normal operation of the equipment. The component support frame shall withstand a live load of 500 lbs.

3. Frames and Covers (Solid Cover):

   a. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and covers and fabricate round frames and covers in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit. Apply shop coat of asphaltum to all units.

   b. Cover – Solid:

      1) 30 inch open diameter
      2) Name of Stormwater Quality Unit manufacture cast into manhole cover.
      3) Lettering: "STORMWATER QUALITY UNIT"

   c. Basis of Design: Similar to Frame Product #41600410 and Cover Product #00180841 by East Jordan Iron Works, Inc.

   d. Material: Heavy Duty Round Frame and Covers, weight at least 350 lbs, meeting ASTM A 48/A 48M, Class 35B gray iron unless otherwise indicated.

   e. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Neenah Foundry Co.
      2) East Jordan Iron Works, Inc (EJ Group, Inc.)
      3) Campbell Foundry
      4) General Foundries

4. Hatch systems

   a. Description: Hatch shall be designed to withstand AASHTO H-20 loadings.

      1) Hatch systems not subject to direct traffic shall be manufactured of Grade 5086 aluminum.

      2) Hatch systems subject to direct traffic loads shall be manufactured of steel conforming to ASTM A 36-93a, supplied with a hot-dip galvanized finish conforming to ASTM A 123 and access doors bolted to the frame.

5. All piping and connections and ancillary items not listed herein shall be provided by the contractor.

6. Performance

a. The stormwater treatment unit shall adhere to the hydraulic parameters listed below and provide the removal efficiencies and storage capacities as follows:

Performance objective: The treatment chamber must be capable of treating a maximum flow at least equal to the peak treatment flow listed below.

Treatment Unit Type:	*Offline*	
Peak Treatment Flow Rate (PTFR:	*3*	*cfs*
Max.Treatment Flow Rate (MTFR):	*1.56*	*cfs*
Vessel diameter:	*4*	*ft.*
Maximum inlet pipe diameter:	*12*	*in.*
Maximum overflow pipe diameter:	*12*	*in.*
Minimium storm drain depth:	*2.8*	*ft.*
Standard depth:	*4.1*	*ft.*
Max head loss at peak treatment capacity:*	*0.68*	*ft.*
Sediment storage capacity:	*0.70*	*cu. yd.*
Oil storage capacity:	*70*	*gal.*
Approximate empty weight:	*10,000*	*lbs.*
Approximate operational weight:	*13,200*	*lbs.*

** Head loss is defined as the difference between static water level at the inlet to the stormwater treatment device to the free water surface in the overflow pipe assuming a free discharge.*

b. The stormwater treatment system shall be a hollow cylindrical vessel with internal components and a tangential inlet to induce a vortex flow pattern that will accumulate and store settleable solids in a sediment storage facility that is isolated from the treatment flow path. The sediment storage facility shall be beneath the vortex chamber to prevent re-entrainment of captured sediment and reduction in treatment capacity.

c. Each stormwater treatment unit shall utilize a submerged inlet to prevent the re-entrainment of trapped floating contaminants without raising the water surface inside the tank.

d. The stormwater treatment system shall have a floatables trap that is separate from the treated effluent discharge area to prevent re-entrainment of captured floatables during surcharge conditions.

e. The useable sediment and oil storage capacities shall not be less than the volumes listed above. The useable sediment storage capacity shall not cause a reduction in the volume of the treatment chamber capacity. The useable oil storage capacity shall not encroach upon the useable sediment storage capacity.

f. Access covers shall be provided for the sediment and floatable contaminant storage areas to facilitate maintenance.

7. Basis of Design Manufacturer

a. The manufacturer of the storm water treatment device shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff and which have a history of successful production, acceptable to the Architect and approved for use by the NYSDEC. The storm water treatment device shall be equivalent to the "Downstream Defender" device manufactured by: Hydro International, 94 Hutchins Drive, Portland, Maine 04102. Telephone: (207) 756-6200. Fax: (207) 756-6212.

2.22 STORMWATER OUTLET STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete as required to prevent flotation.

2. Grade Rings: Include two or three reinforced-concrete rings, of 6-inch to 9-inch total thickness, that match 24-inch- diameter frame and cover.

3. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12-inch to 16-inch intervals. Omit steps if total depth from floor of structure to finished grade is less than 60 inches.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7-inch to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2.23 PIPE OUTLETS

A. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."

1. Average Size: NSSGA No. R-3, screen opening 2 inches.
2. Average Size: NSSGA No. R-4, screen opening 3 inches.
3. Average Size: NSSGA No. R-5, screen opening 5 inches.

B. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

C. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

2.24 IDENTIFICATION

A. Underground Warning Tape

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Presco, Inc.; Sherman, Texas
b. EMED Co., Buffalo, New York.
c. Seton Identification Products, A Tricor Direct Company.

2. Material: 6-inch wide, color-coded, heavy gauge 5-mil tape with aluminum backing.

3. All tapes printed with black ink on APWA (American Public Works Association) approved colors to meet or exceed industry standards.

4. Location: Provide warning tape 18 inches feet below finished grade in buried piping trenches and at foundation wall.

2.25 CONCRETE

A. Cast-in-Place Concrete: Refer to Div 03 concrete section for concrete strength, mixtures, fiber reinforcement and other requirements.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.

3. Install piping with 24-inch minimum cover.

4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

5. Install corrugated steel piping according to ASTM A 798/A 798M.

6. Install PE corrugated sewer piping according to ASTM D 2321.

7. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Install force-main pressure piping according to the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.

2. Install piping with 60-inch minimum cover.

3. Install PVC pressure piping according to AWWA M23, or ASTM D 2774 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
3. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

B. Join force-main pressure piping according to the following:

1. Join PVC pressure piping according to AWWA M23 for gasketed joints.
2. Join dissimilar pipe materials with pressure-type couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification drains in roads.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

3.6 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections with sealants according to ASTM C 891.
C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.
B. Set frames and grates to elevations indicated.

3.8 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
B. Construct riprap of broken stone, as indicated.
C. Install outlets that spill onto grade, anchored with concrete, where indicated.
D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
E. Construct energy dissipaters at outlets, as indicated.

3.9 DRY WELL INSTALLATION

A. Excavate hole to diameter of at least 6 inches greater than outside of dry well. Do not extend excavation into ground-water table.

B. Install precast, concrete-ring dry wells according to the following:

1. Assemble rings to depth indicated.
2. Extend rings to height where top of cover will be approximately 8 inches below finished grade.
3. Backfill bottom of inside of rings with filtering material to level at least 12 inches above bottom.
4. Extend effluent inlet pipe 12 inches into rings and terminate into side of tee fitting.
5. Backfill around outside of rings with filtering material to top level of rings.
6. Install cover over top of rings.

3.10 CONCRETE PLACEMENT

A. Place and test cast-in-place concrete according to ACI 318 and Division 03 concrete section**.**

3.11 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.
B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.
D. Fasten grates to channel sections if indicated.
E. Assemble channel sections with flanged or interlocking joints.
F. Embed channel sections in 4-inch minimum concrete around bottom and sides.

3.12 STORMWATER DISPOSAL SYSTEM INSTALLATION

A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

3.13 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Division 22 Section "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3,000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3,000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3,000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use non-pressure-type flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.

    a. Shielded flexible couplings for same or minor difference OD pipes.

b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.14 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.

2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.15 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.16 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.

4. Submit separate report for each test.

5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.

a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.17 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 33 41 00