Addendum 6

December 7, 2022
SUCF 081058-00 Upgrade Elevators - Campus Wide at SUNY New Paltz, 1 Hawk Dr. New Paltz, NY 12561

Prepared for the "State University Construction Fund"
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The following additions, deletions, and/or changes or clarifications to the drawings, specifications, and bidding documents for this project, shall become and are hereby made part of the Contract Documents. They change the original documents only in the manner and to the extent stated. Each bidder shall acknowledge receipt of this Addendum in the appropriate location on the bid proposal form.

This addendum consists of five (5) pages and twenty-eight (28) attachments.

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TABLE OF CONTENTS:

Revisions to the Specifications:

1. Specification Section 01 35 73 Delegated Design
Add the following portions of the design work to the schedule of delegated design –

Section Number: 22 05 49;
Section Name: Plumbing Vibration Controls and Seismic Restraints;
Description of Delegated Design (See Section for complete details): Seismic supports for Risk Category IV and Seismic Design Category C.

Section Number: 23 05 49;
Section Name: Mechanical Vibration Controls and Seismic Restraints;
Description of Delegated Design (See Section for complete details): Seismic supports for Risk Category IV and Seismic Design Category C.

2. Specification Section 22 05 49 Plumbing Vibration Controls and Seismic Restraints
Replace entire section with attachment 1.

3. Specification Section 22 14 29 Sump Pump
Replace entire section with attachment 2.

4. Specification Section 23 05 14 Variable Frequency Drives
Remove section in its entirety.

5. Specification Section 23 05 48 Mechanical Vibration Controls
Replace entire section with attachment 3.

6. Specification Section 23 05 49 Mechanical Vibration Controls and Seismic Restraints
Add attachment 4.

7. Specification Section 23 07 19 HVAC Piping Insulation
Replace entire section with attachment 5.

8. Specification Section 23 09 00 Direct Digital Automatic Temperature Controls
Replace entire section with attachment 6.

9. Specification Section 23 20 00 HVAC Piping and Joints
Replace entire section with attachment 7.

10. Specification Section 23 39 00 Fans and Accessories
Replace entire section with attachment 8.

11. Specification Section 23 81 26 Split System Air Conditioners
Replace entire section with attachment 9.

Revisions to the Drawings:

1. CSB-E101
Replace drawing 2 with attachment 13.

2. SAB-E101
Replace drawing 2 with attachment 19.

3. HAB-E101
Replace drawing 2 with attachment 15.

4. LC-E101
Replace drawing 2 with attachment 17.

5. STL-E101
Replace drawing 2 with attachment 22.

Replace drawing 5 with attachment 23.

Replace drawing 7 with attachment 21.

6. SUB-E101
Replace drawing 2 with attachment 27.

7. CSB-E601
Revise panel schedule for panel PP-A as shown on attachment 14.

8. SAB-E601
Revise panel schedule for panel PP-A as shown on attachment 20.

9. HAB-E601
Revise panel schedule for panel PP-A1 as shown on attachment 16.

10. LC-E601
Revise panel schedule for panel PP-A as shown on attachment 18.

11. STL-E601
Revise panel schedule for panel PP-A1 as shown on attachment 24.

Revise panel schedule for panel PP-A2 as shown on attachment 25.

Revise panel schedule for panel PP-A3 as shown on attachment 26.

12. SUB-E601
Revise panel schedule for panel PP-A as shown on attachment 28.

13. A911
Add the following general note –
Provide 22 ga aluminum sandwich panel, insulated, 1” thick at all locations where existing louver openings are being blanked off.

14. P501
Add drawing on attachment 10.

15. M402
Revise control point list as shown on attachment 11.

16. M502
Add drawing on attachment 12.

SECTION 220549 – PLUMBING VIBRATION CONTROLS AND SEISMIC RESTRAINTS (HAGGERTY ADMINISTRATION BUILDING ONLY)

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Unless the structural drawings indicate the Seismic Design Category determined in accordance with either Section BC 1613 or ASCE 7-2010, the systems shall be designed as Seismic Design Category C, Structural Occupancy/Risk Category IV “Buildings and other structures designated as essential facilities” for seismic design as per Table BC 1604.5.

B. Provide a complete system of vibration isolation and seismic bracing for each item of Plumbing piping, ductwork, and equipment as specified herein and as needed for a complete and proper installation. Provide bracing for the equipment as shown on the Drawings.

C. All piping, and equipment shall be seismically secured in accordance with Article 3.05 (with the exception of systems qualifying for exclusions as defined in Article 3.05).

D. All equipment, piping, and ductwork as noted in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

E. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

F. It is the intent of the seismic portion of this specification to keep all mechanical building system components in place during a seismic event and to prevent the release of hazardous or flammable materials contained within building mechanical systems.

G. All such systems must be installed in strict accordance with the seismic codes, component manufacturers’ and building construction standards. Whenever a conflict

occurs between the manufacturers' and construction standards, the most stringent shall apply.

H. This specification is considered to be the minimum requirements for seismic consideration and is not intended as a substitute for more stringent national, state, or local construction requirements.

I. The work in this section includes, but is not limited to the following:

1. Vibration isolation and seismic bracing for

2. Equipment isolation bases

3. Flexible piping connections

4. Seismic bracing for isolated equipment

5. Seismic bracing for non-isolated equipment

J. All mechanical systems are included. Equipment buried underground is excluded but entry of services through the foundation wall is included.

1. Equipment listed below is typical and is not to be construed as complete.

Pumps	Piping

2. In general, where the failure of the equipment supports would cause a life safety hazard (to personnel or to other systems) such equipment shall be designed to resist the seismic forces.

K. All vibration isolators and seismic bracing described in this section shall be the product of a single manufacturer.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.

1.05 DEFINITIONS

A. ICC-ES: International Code Council Evaluation Service

1. ICC-ES performs technical evaluations of building products, components, methods, and materials and reports on code compliance.

B. Positive Attachment

~~1.~~ A positive attachment is defined as a cast-in anchor, a seismic drilled-in wedge anchor or anchor bolt ICC certified for cracked concrete, adhesive anchor, or a welded or bolted connection to structure. Beam clamps (2 sided or 1 sided beam clamps with restraining straps) are only allowed for hangers and are not permitted for seismic braces per ASCE 7-10 Section 13.4.6.

C. Transverse Bracing

1. Bracing which limits motion perpendicular to the centerline of the pipe or duct.

D. Longitudinal Bracing

1. Bracing which limits motion parallel to the centerline of the pipe or duct.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:

1. Product Descriptions

a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.

b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:

1) Equipment identification mark
2) Isolator type
3) Actual load
4) Static deflection expected under actual load
5) Specified minimum static deflection
6) Additional deflection-to-solid under load
7) Ratio of spring height under load to spring diameter
8) Base type
9) Seismic restraint type

c. Steel rails, steel base frames, showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.

3. Indicate isolation devices selected with complete dimensional and deflection data.

4. Show all methods of suspension and support for ceiling hung equipment.

5. Detail methods of isolation for ducts and pipes piercing walls and slabs.

6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.

7. Provide special details necessary to convey complete understanding of the work to be performed.

1.07 SUPPLEMENTAL SUBMITTALS

A. The manufacturer of vibration isolation and seismic bracing shall provide submittals for products as detailed below. These are to be submitted for record purposes only. Contractor’s Registered Professional Engineer shall sign

and seal submittals. Architect/Engineer of Record shall verify that the structural support system can support all seismic loads where the bracing is attached to the structure.

B. Descriptive Data

1. Catalog cuts or data sheets on vibration isolators and specific bracing detailing compliance with the specification.

2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic bracing.

3. Catalog cuts or data sheets on anchors.

C. Shop Drawings: Shop drawings shall be signed/sealed by the Contractor's registered Professional Engineer.

1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

2. Provide all details of suspension and support for ceiling hung equipment.

3. Where walls, floors, slabs or supplementary steel work are used for seismic bracing locations, details of acceptable attachment methods for ducts and pipe must be included and approved before the condition is accepted for installation. Bracing manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

4. Provide specific details of seismic bracing and anchors; include number, size and locations for each piece of equipment.

5. The sound power levels shall be included with data submitted for the equipment.

6. Pipe details for crossing seismic or expansion joints, bracing or attachments to dissimilar building systems or dissimilar parts of the building and service entry

D. Seismic Certification and Analysis

1. Seismic bracing calculations must be provided for all connections of equipment to the structure. Drawings and calculations must be stamped by the Contractor's registered professional engineer with at least five

years of seismic design experience in non-structural building components, licensed in New York State.

2. All bracing devices shall be tested and certified in accordance with ICC-ES AC 156 or other recognized government agency showing maximum ratings. Local NYC accelerations are to be used when computing seismic inertia forces. Where preapproved devices are not available, submittals based on independent testing shall be provided. Calculations (including the combination of tensile and shear loadings relative to seismic bracing designs) must be stamped by a registered professional engineer licensed in New York State with at least five years of seismic design experience. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode. Professional Engineer shall be retained by the Contractor at his/her expense.

3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length. All seismic bracing devices shall be designed to accept, without failure, the accelerations detailed herein acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

4. Wedge Anchor/expansion bolt – ICC-ES Reports for cracked concrete, including seismic applicability.

5. Adhesive anchor - ICC-ES Reports

6. Air Mounting Systems: natural frequency, load and damping tests performed by independent lab or acoustician

7. Riser diagrams and calculations showing anticipated expansion and contraction.

E. Submit welding certificates. Qualify welding procedures and personnel according to AWS D1.1, “Structural Welding Code-Steel.”

1.08 SUPPLEMENTAL QUALITY ASSURANCE

A. Manufacturer’s Qualifications

1. Isolator/Bracing manufacturer shall be regularly engaged in the manufacturing of vibration isolating

and seismic bracing materials, whose products have been in satisfactory use in similar service for not less than five years.

B. Seismic Engineer's Qualifications and Duties

1. The Contractor shall engage the services of a third party Registered Professional Engineer (not a direct employee), who shall have a minimum of five years seismic design experience in non-structural building components and shall be licensed in New York State.

a. For combination vibration isolator/seismic restraints, the Contractor's registered professional engineer shall determine vibration isolation and seismic bracing sizes and locations and provide field supervision and inspection to ensure proper installation and performance.

b. For separate seismic restraints not combined with vibration isolators, Contractor's registered professional engineer shall determine seismic bracing sizes and locations and provide field supervision and inspection to ensure proper installation and performance.

c. The Contractor's registered professional engineer shall prepare and sign and seal shop drawings of the seismic design.

1.09 SUPPLEMENTAL CODE AND STANDARDS REQUIREMENTS

A. Chapter 16 of the Building Code

B. ASCE 7–2010 Minimum Design Loads for Buildings and Other Structures.

C. ASHRAE: Practical Guide to Seismic Restraint, 1999

D. ANSI/SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition, 2008.

1.10 RELATED WORK

A. Supplementary Support Steel

1. Contractor shall supply supplementary support steel for all equipment, piping, etc. including roof mounted equipment, as required or specified.

B. Attachments

1. Contractor shall supply bracing attachment plates cast into housekeeping pads, concrete inserts, etc. in accordance with the requirements of the vibration vendor's calculations.

1.11 SEISMIC ACCELERATION LEVELS

A. The horizontal accelerations (in g's) are defined as the ratio of the horizontal seismic force to the weight of the element being braced. For purposes of calculating design seismic forces in non-building structures, the weight shall also include all normal operating contents for items such as tanks, vessels, and piping.

B. Seismic bracing shall be designed for seismic effects/accelerations as per Chapter 16 of the Building Code and ASCE 7-2010. Refer to Article 3.05 "Seismic Bracing/Restraint of Plumbing Piping, Equipment and Ductwork" for description of required items to be designed and constructed to seismic requirements.

1. Seismic Design Category and Seismic Accelerations are indicated on the Structural Drawings.

2. Component Importance Factors are indicated in the "Component Seismic Importance Factors Ip" schedule on the Mechanical (Plumbing) Drawings. Per Section BC 1604.5.2, Importance Factors for seismic loads shall be determined in accordance with BC Table 1604.5.2 based on the Structural Occupancy Category/Risk Category assigned in accordance with BC Table 1604.5.

PART 2 – PRODUCTS

2.01 ISOLATORS AND RESTRAINTS – GENERAL

A. Acceptable Manufacturers subject to compliance to specifications.

1. Mason Industries (MI)
2. Amber/Booth (AB)
3. Kinetics Noise Control (KNC)
4. Vibration Eliminator Co. (VEC)
5. Vibration Mountings & Controls (VMC)

2.02 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the manufacturers specified.

B. Failure is defined as the discontinuance of any attachment point between equipment and structure, vertical permanent deformation greater than 1/8″ and/or horizontal permanent deformation greater than 1/4″.

2.03 PRODUCT DESCRIPTIONS

A. Vibration Isolators

1. Manufacturers:

a. Mason Industries Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls/Korfund

d. International Seismic Application Technology (ISAT)

2. Elastomeric isolator pads: Oil and water resistant elastomer, arranged in single or multiple layers, molded with a non-slip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment. The neoprene pads shall be sized for a load of 50 pounds per square inch and shall be a minimum of 5/16″ thick.

a. Material: bridge bearing neoprene, complying with AASHTO M 251.

b. Durometer rating and number of layers as required for stiffness and deflection based on supported load.

3. Elastomeric Mounts: Double deflection type, with molded oil resistant rubber or neoprene isolator elements with factory drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color code or otherwise identify to indicate capacity range.

a. Durometer rating as required for stiffness and deflection based on supported load.

4. Spring Isolators: Freestanding, laterally stable, open spring isolators.

a. Outside spring diameter not less than 80% of the compressed height of the spring at rated load.

b. Minimum additional travel shall be 50% of the required deflection at rated load.

c. Lateral stiffness shall be more than 80% of the rated vertical stiffness.

d. Overload capacity: Support 200% of rated load, fully compressed, without deformation or failure.

e. Baseplates: Factory drilled for bolting to structure and bonded to 5/16" thick rubber isolated pad attached to baseplate underside. Baseplates shall limit floor load to 50 psig.

f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

5. Restrained Spring Isolators: Freestanding, steel, open spring isolators with seismic restraint.

a. Housing: Steel with resilient vertical limit stops to prevent spring extension due to wind loads or if weight is removed; factory drilled baseplate bonded to 5/16" thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

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

c. Minimum Additional Travel: 50% of the required deflection at rated load

d. Lateral Stiffness: More than 80% of the rated vertical stiffness

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

f. Housing shall be designed to resist all seismic forces. Mountings shall be tested and certified in accordance with ICC-ES AC 156 for the maximum certified horizontal and vertical load ratings.

6. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

a. Housing: Ductile iron or steel housing to provide all directional seismic restraint.

b. Base: Factory drilled for bolting to structure.

c. Snubbers: Vertically adjustable to allow a maximum of 1/4″ travel before contacting a resilient collar.

d. Mountings shall be tested and certified in accordance with ICC-ES AC 156 for the maximum certified horizontal and vertical load ratings.

7. Thrust Limits: The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc. or approved equal.

8. Resilient Pipe Guides: Telescopic arrangement of two steel tubes separated by a minimum of 1/2″ thick 60 durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

B. Air Mounting Systems

1. Manufacturers:

a. Mason Industries

b. Vibration Eliminator Co., Inc.

c. International Seismic Application Technology (ISAT)

2. Air Mounts: Freestanding, single or multiple, compressed-air bellows.

a. Assembly: Upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene bellows

b. Maximum Natural Frequency: 3Hz

c. Operating Pressure Range: 25 to 100 psig

d. Burst Pressure: At least three times the manufacturer’s published maximum operating pressure

e. Leveling Valves: Minimum of three required to maintain leveling within plus or minus 1/8”.

f. Submittals shall include natural frequency, load and damping tests performed by independent lab or acoustician.

3. Restrained Air Mounts: Housed Compressed Air Bellows

a. Assembly: Upper and lower sections connected by a replaceable flexible nylon reinforced neoprene bellows and spring, with angle iron frame having vertical limit stops and channel section top with leveling adjustment and attachment screws.

b. Maximum Natural Frequency: 3 Hz

c. Operating Pressure Range: 25 to 100 psig

d. Burst Pressure: At least three times the manufacturer’s published maximum operating pressure

e. Leveling Valves: Minimum of 3 required to maintain leveling with plus or minus 1/8”.

f. Housings shall be designed to resist all seismic forces.

C. Seismic Bracing/Restraint Devices

1. Manufacturers:

a. Mason Industries, Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls/Korfund

d. International Seismic Application Technology (ISAT)

2. Restrained Elastomeric Mount: Bridge bearing neoprene mountings shall have a minimum static deflection of

0.2″ and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposed molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications. Mountings shall be tested and certified in accordance with ICC-ES AC 156 for the maximum certified horizontal and vertical load ratings. Mountings shall be Mason Industries Type BR or approved equal.

3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve shall prevent the sheet metal from cutting into the neoprene. Panel holes shall be enlarged as required. Neoprene elements shall pass over the bushing to cushion the back panel horizontally. A steel disc shall cover the inside neoprene element and the inner steel sleeve shall be elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies shall be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc. or approved equal.

4. Washer/Bushing: A one-piece molded bridge bearing neoprene washer/bushing shall be used. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc. or approved equal.

5. Seismic cable bracing shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional bracing. Cables shall be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables shall not be allowed to bend across sharp edges. Cable assemblies shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified load ratings. Cable assemblies shall be secured with Mason Industries Type SCB (or approved equal) at the ceiling and at the clevis bolt. Mason Industries Inc. type SCBH (or

approved equal) shall be used between the hanger rod nut and the clevis. Mason Industries type SCBV (or approved equal) shall be used if cable is clamped to a beam.

6. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc. or approved equal.

7. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each bracing location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be tested and certified in accordance with ICC-ES AC 156. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc. or approved equal.

8. Pipe clevis cross bolt braces are required in all bracing locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall be tested and certified in accordance with ICC-ES AC 156. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc. or approved equal. See Figure 3-9 of ASHRAE Practical Guide to Seismic Restraint, 1999.

9. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" thick. Rated loadings shall not exceed 1000 psi. A minimum air gap of 1/8" shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1225

as manufactured by Mason Industries, Inc. or approved equal.

10. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more that 1/4". Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" deflection in the x, y and z planes. Snubbers shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-1011 as manufactured by Mason Industries, Inc. or approved equal.

11. Expansion/Screw/Adhesive Anchors:

    a. Anchors in concrete or masonry shall be in accordance with ASCE 7-10 Section 13.4.2.

        1) As a minimum, all anchors exposed to weather or embedded in masonry are to be Type 316 stainless steel.

        2) Anchors installed in concrete shall have current ICC-ES listing for performance in cracked concrete as per Section BC 1912 of the 2014 NYC Building Code.

            a) Wedge Expansion and Undercut Anchors/ expansion bolts/screw anchors shall have an ICC-ES Evaluation Service Report (ESR) issued in accordance with ICC-ES AC 193 for use in cracked concrete, including seismic applicability loading.

            b) Adhesive anchors in concrete shall have an ICC-ES Evaluation Service report (ESR) issued in accordance with ICC-ES AC 308 for use in cracked concrete, including seismic applicability loading, and pursuant to

the Office of Technical Certification and Research (OTCR) Building Bulletin 2009-019.

12. Stud wedge anchors shall be epoxy adhesive based and manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall be tested and certified in accordance with ICC-ES AC 156 verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc. or approved equal.

13. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be epoxy adhesive based and manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall be tested and certified in accordance with ICC-ES AC 156 verifying their allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc. or approved equal.

D. Vibration Isolation Equipment Bases

1. Manufacturers (as listed, or approved equal)

   a. Mason Industries Inc.

   b. Vibration Eliminator Co., Inc.

   c. Vibration Mountings & Controls/Korfund

   d. International Seismic Application Technology (ISAT)

2. Steel base: Integral structural steel base shall be provided. Independent steel rails are not permitted on this project. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14″ provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

   a. Design Requirements: Lowest possible mounting height with not less than 1″ clearance above the floor. Include equipment anchor bolts and

auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A 36M. Bases shall have shape to accommodate supported equipment.

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

3. Equipment anchor bolts with bottom plates and pipe sleeves shall be preset.

PART 3 – EXECUTION

3.01 PREPARATION

A. For vibration isolation and seismic bracing equipment installed indoors, all metal parts, including rails and bases, shall be painted at the factory with one coat of primer paint and one coat of aluminum paint. Other means or rust resisting painting may be accepted, subject to prior approval.

B. Vibration isolation and seismic bracing equipment installed outdoors shall have all steel parts hot dipped galvanized, all bolts cadmium plated, and all springs cadmium plated and neoprene coated.

C. Vibration isolation and seismic bracing equipment installed outdoors shall be designed and installed to resist wind loads in accordance with the Building Code.

3.02 SUPPLEMENTAL INSTALLATION

A. At each equipment location, provide the required deflection under the imposed load to produce uniform loading and deflection even when equipment weight is not evenly distributed. Springs shall be designed and installed so that the ends remain parallel during and after spring deflection to operating height. Jack inertia blocks and bases into position and wedge in place before spring loading; leveling bolts shall not be used as jacking screws. After equipment is in place and springs are loaded through leveling bolts, remove wedges and jacks. Isolators shall be suitable for the lowest operating speed of the equipment. Vertical limit stops shall be out of contact during normal operation.

B. Where the floor is waterproofed or finished with waterproof cement, install seismic bracing and vibration isolation in such manner that the waterproofing is not damaged.

C. Isolation equipment shall be in accordance with the following table:

Lowest RPM	Inches Deflection (Min.)	% Efficiency (Min.)	Type
1750 & over	.25	95	Single Neoprene- in-shear
1200-1749	.50	95	Double Neoprene-in-shear
1000-1199	.75	95	Spring
570-999	1.25	90-95	Spring
520-569	1.5	90	Spring
330-519	2.0	80-90	Spring
Up to 329	3.5	80	Spring

D. Install combination spring and double deflection neoprene position hangers on all refrigeration piping located in the Equipment Room.

E. The minimum horizontal isolation required for equipment piping shall be installed as follows:

1. Metal piping connected to power driven equipment shall be resiliently supported from or on the building structure from the power driven equipment for a distance of the maximum of 50 pipe diameters or the first three pipe hangers, whichever is the longest length. The isolators shall be pre-compressed spring and neoprene type hangers. Pre-compressed spring and neoprene type hangers must also be used in all transverse braced isolated locations. Horizontal runs in all other locations throughout the building shall be isolated by spring and neoprene hangers that need not be pre-compressed. Floor supported piping shall rest on isolators such as Mason Industries SLR spring mounts (or approved equal).

   a. The resilient isolators shall have a minimum static deflection of 1″ for all piping with a 4″ or larger in actual outside diameter and 1/2″ (12.7 mm) for piping with less than 4″ in actual outside diameter.

   b. Piping connected to fluid pressure-reducing valves shall be resiliently isolated for a distance of 50 pipe diameters from pressure reducing valves and isolators shall provide a minimum static deflection of 1/2″.

3.03 SCHEDULE

A. Provide vibration isolation supports for Plumbing equipment as indicated in this schedule. Contractor shall submit a schedule for approval by Engineer of Record indicating the type of support for each item of Plumbing & Drainage Equipment and each item of Electrical Equipment.

Equipment	Location	Type of Support
Pump, all H.P.	cellar/basement	none required
Pump, under 3 H.P.	upper floor	none required
Pipe	at pumps hanger	spring and D.D.*

*D.D. = Double Deflecting

3.04 GENERAL

A. All vibration isolators and seismic bracing systems shall be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic bracing shall not cause any change of position of equipment, piping resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any equipment, piping, or duct that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor’s expense.

G. Bring to the architects/engineers attention any discrepancies between the Contract Documents and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor’s expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials.

1. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:

a. Flanges of structural beams.

b. Upper truss cords in bar joist construction.

c. Expansion bolts/ wedge type drilled-in concrete anchors/adhesive anchors.

I. Cable bracing shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

J. Cable assemblies are installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.

K. At locations where cable or seismic solid brace restraints are located, the gravity support rods must be braced when necessary to accept compressive loads by clamping with steel angles that are sized to prevent the buckling of the rods. A minimum of three ductile iron clamps shall be used. Welding of support rods is not acceptable.

L. At all locations where cable or seismic solid brace restraints are attached to pipe clevises, the clevis cross bolt must be reinforced with braces.

M. Drill-in concrete anchors for ceiling and wall installation shall be provided and female wedge type anchors shall be used for floor mounted equipment.

N. Vibration isolation manufacturer shall furnish integral structural steel bases (or inertia bases) as required. Independent steel rails are not permitted.

O. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed support capabilities.

P. Air handling equipment shall be protected against excessive displacement that results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be used.

Q. Locate isolation hangers as near to the overhead support structure as possible.

R. When the equipment sound levels exceed the specified noise criteria, removable acoustic enclosures, alterations to the equipment, or other approved means shall be provided to reduce equipment sound level to that specified.

3.05 SEISMIC BRACING/RESTRAINT OF PLUMBING PIPING, EQUIPMENT

A. Per ASCE 7-10, for Seismic Category C, seismic bracing shall be provided for all Plumbing equipment and distribution systems with Ip=1.5.

B. For HVAC equipment and systems in Seismic Design Category C with Ip=1.0, seismic bracing shall be provided unless the distance, weight and size exceptions as defined in ASCE 7-2010 as modified below are met.

C. Seismic braces are not required provided that the component importance factor, Ip, is equal to 1.0. (Section 13.1.4 Exception 5.)

D. Seismically restrain piping with cables if isolated. Cables or seismic solid brace restraints may be used on unisolated piping.

E. Transverse piping bracing shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

F. Longitudinal bracing shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

G. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal bracing provided they have a capacity equal to or greater than the bracing loads in addition to the loads induced by expansion or contraction.

H. Transverse bracing for one pipe section may also act as a longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.

I. Hold down clamps must be used to attach pipe to all trapeze members before applying bracing in a manner similar to clevis supports.

J. Branch lines may not be used to brace main lines.

K. For Seismic Design Categories C and D, restrain components with Ip=1.0 located above or in proximity to components with Ip=1.5 that could damage components with Ip=1.5.

3.06 BUILDING SEISMIC OR EXPANSION JOINTS

A. Provide building seismic or expansion joints in accordance with ASCE 7-10 Section 13.6.3.3. Provide pipe offsets, loops, and guides; pipe ball joints; pipe swing joints and expansion joints utilizing grooved pipe; flexible braided stainless steel pipe loops and flexible braided bronze pipe loops; or other flexible joints capable of accommodating seismic displacements where pipes pass through building seismic or expansion joints, the width of which are shown on the Structural Drawings. Refer to the ANSI/SMACNA Seismic Restraint Manual, 3rd Edition, 2008. Reference is also made to Figs. 7-19 and 7-20 of the 1999 ASHRAE Practical Guide to Seismic Restraint for ductwork systems that cross building seismic joints. A rigid piping or duct system shall not be braced or attached to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake without providing the above mechanisms to absorb the movement.

B. Joints, offsets, loops, anchors and guides shall accommodate bending, torsion, compression and extension. The Contractor’s registered professional engineer shall detail all piping and duct joints that pass through building seismic or expansion joints. The Contractor’s registered professional engineer shall also detail all piping and duct joints required as a result of bracing or attachment to dissimilar building systems or dissimilar parts of the building.

3.07 FIELD QUALITY CONTROL

A. Cooperate with the owner and provide all required access to facilitate all testing and inspection related to the Special Inspection.

B. On completion of the vibration isolation system herein specified, the representative of the vibration isolation manufacturer shall inspect the completed systems and report in writing any installation error, improperly selected isolation devices, or any other faults that could affect performance.

C. The Contractor’s Engineer for combination seismic restraints/vibration isolators shall make field inspections to ensure the restraint/isolator construction is in accordance with his/her design documents and shop drawings. The Contractor’s Engineer for separate seismic restraints

not combined with vibration isolators shall make field inspections to ensure the restraint construction is in accordance with his/her design documents and shop drawings.

3.08 EQUIPMENT VIBRATION ISOLATOR AND SEISMIC BRACING/RESTRAINT SCHEDULE

A. Equipment vibration isolation and seismic bracing schedule shall be submitted by the Contractor’s registered professional engineer. Schedule shall list all equipment with associated isolators and seismic bracing as well as the static deflections of each piece of equipment when mounted on its isolators. Contractor’s registered professional engineer shall indicate on the schedule if equipment only requires seismic bracing, requires seismic bracing as well as vibration isolators, mounted on steel dunnage, directly mounted to pad or mounted on concrete filled inertia base.

END OF SECTION 230549

SECTION 221429 – SUMP PUMP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sump pumps and accessories, inside the building, for building storm drainage systems:

1. Submersible sump pumps.

1.3 SUBMITTALS

A. Product Data: For each type and size of sump pump specified. Include certified performance curves with operating points plotted on curves, and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For each sump pump to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. 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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of pits. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 SUMP PUMPS

A. Manufacturers:

1. ABS Pumps, Inc.
2. Aermotor Pumps, Inc.
3. Barnes; Crane Pumps & Systems.
4. Bell & Gossett Domestic Pump; ITT Industries.
5. BJM Corporation.
6. EBARA International Corporation; Standard Pump Division.
7. Federal Pump Corp.
8. Gorman-Rupp Company (The).
9. Goulds Pumps; ITT Industries.
10. Grundfos Pumps Corp.
11. Liberty Pumps.
12. Little Giant Pump Co.
13. McDonald, A. Y. Mfg. Co.
14. Metropolitan Industries, Inc.
15. Myers, F. E.; Pentair Pump Group (The).
16. Paco Pumps, Inc.
17. Stancor, Inc.
18. Sta-Rite Industries, Inc.
19. Swaby Manufacturing Co.
20. Weil Pump Company, Inc.
21. Weinman Div.; Crane Pumps & Systems.

22. Zoeller Company.
23. Or other approved equals.

B. Description: Factory-assembled and -tested, simplex, centrifugal, end-suction, submersible, direct-connected sump pumps complying with UL 778 and HI 1.1-1.2 and HI 1.3 for sump pumps.

C. Casing: Cast iron; with cast-iron inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange for piping connection.

D. Impeller: ASTM A 48/A 48M, Class No. 25 A or higher cast iron; statically and dynamically balanced, semiopen nonclog design, overhung, single suction, keyed and secured to shaft.

E. Casing and Impeller: Cast-iron casing with metal inlet strainer and brass, bronze, or cast-iron impeller.

F. Bearing: Renewable graphite sleeve bearings at pumps case and renewable graphite sleeve bearings at the intermediate bearing location.

G. Pump Discharge Piping: see section 221000

H. Controls: Control shall be by a Type SBS Submers-a-bulb Controller, including four mercury bulbs on a Style 1 suspension bracket. A NEMA-4 junction box shall be provided plus a control panel in a NEMA-4 wall -mounting enclosure, including therein a fusible disconnect switch and a magnetic starter for each motor, HOA selector switches, automatic pump alternator, pump-run lights, and an alarm bell, silencer button and light to indicate high water condition. The control panel shall be of the solid-state type with encapsulated plug-in circuit board and plug-in relays.

2.3 HYDRAULIC ELEVATOR SUMP PUMP

A. Manufacturers:

1. ABS Pumps, Inc.
2. Aermotor Pumps, Inc.
3. Barnes; Crane Pumps & Systems.
4. Bell & Gossett Domestic Pump; ITT Industries.
5. BJM Corporation.
6. EBARA International Corporation; Standard Pump Division.
7. Federal Pump Corp.
8. Gorman-Rupp Company (The).
9. Goulds Pumps; ITT Industries.
10. Grundfos Pumps Corp.

11. Liberty Pumps.
12. Little Giant Pump Co.
13. McDonald, A. Y. Mfg. Co.
14. Metropolitan Industries, Inc.
15. Myers, F. E.; Pentair Pump Group (The).
16. Paco Pumps, Inc.
17. Stancor, Inc.
18. Sta-Rite Industries, Inc.
19. Swaby Manufacturing Co.
20. Weil Pump Company, Inc.
21. Weinman Div.; Crane Pumps & Systems.
22. Zoeller Company.
23. Or other approved equals.

B. Provide a submersible sump pump and controllers for same that preclude oil from oil laden waste water from discharging into the drainage system. The oil containment system, sump pump and other accessories, for controlling inadvertent oil discharge into the sewer lines shall function automatically and shall allow for water to be pumped from the elevator pit and to stop flowing upon detection of any trace of oil. The system shall include an alarm and LED lights that shall provide a warning in the event of: (a) the presence of oil in the pit and (b) high water level condition. In addition, LED lights shall indicate: (1) power to the motor and (2) pump run function. Provide alarms with separate and distinct sounds for: high water level situation, presence of oil in the pit, power on and pump run function. The warning signal shall be delivered to the Indicator Panel of the Auxiliary Signal System.

C. The pump shall be approved to UL 778 standards and shall include thermal and overload protection. The motor shall be capable of operating continuously or intermittently. The motor housing shall be constructed of #304 stainless steel and mechanical seats shall be housed in a separate oil-filled compartment. The pump shall be placed in a concrete pit for which a frame and split cover shall be provided. The cover shall be of 5/16″ steel checkered plate drilled for installation of the pump, oil-minder probe and float guide.

D. Provide check valve and connect discharge piping to the building drainage system via an air gap or an air break.

E. The main control shall be approved to UL 508 and housed in a gasketed NEMA 4X enclosure with a see-through window for observation of operating functions. The control panel shall come equipped with an 8-pin twist lock receptacle, dual solid state Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with alarm

silencing switch, dual floats, clearly marked terminal board and remote monitoring contact. A NEMA 4X junction box with 8-pin twist-lock electrical receptacle and mating 8-conductor cable shall be provided. The 8-conductor cable shall be extended via a 2″ electrical conduit for final connection to the twist lock outlet that is integral to the control panel. The control unit, junction box, pump, floats and sensor shall be factory assembled as a complete, ready-to-use system and shall be tested and approved as a complete system by a nationally recognized testing laboratory. The system shall allow for the main control to be located outside of the elevator hoistway to be monitored for all functions without having to enter the elevator shaft.

F. Provide stainless steel screws for all anchoring and nailing of pit cover and angle frame

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 SUMP PUMP INSTALLATION

A. Install sump pumps according to applicable requirements in HI 1.4.

B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

C. Set submersible sump pumps in pit or floor.

D. Support piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

A. Install piping adjacent to sump pumps to allow service and maintenance.

B. Install discharge piping equal to or greater than size of pump discharge piping.

C. ALL CONNECITON TO EXISTING SANITARY OR STORM SYSTEM FROM SUMP PUMP SHALL BE INDIRECT CONNECTION.

1. Install flexible connectors adjacent to pumps in discharge piping.
2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 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 bearing lubrication.
3. Disconnect couplings and check motors for proper direction of rotation.
4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
5. Verify that pump controls are correct for required application.

B. Start pumps without exceeding safe motor power:

1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance

in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control of pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221429

SECTION 230548 – MECHANICAL VIBRATION CONTROLS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all necessary vibration isolation materials to eliminate excessive noise and vibration from all building mechanical systems.

B. Secure all permits and local/state approval for the installation of all components included under this Section.

C. The work in this Section shall include the following:

1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:

1. Product Descriptions

a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.

b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:

1) Equipment identification mark
2) Isolator type
3) Actual load
4) Static deflection expected under actual load
5) Specified minimum static deflection
6) Additional deflection-to-solid under load
7) Ratio of spring height under load to spring diameter
8) Base type

c. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.

3. Indicate isolation devices selected with complete dimensional and deflection data.

4. Show all methods of suspension and support for ceiling hung equipment.

5. Detail methods of isolation for ducts and pipes piercing walls and slabs.

6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.

7. Provide special details necessary to convey complete understanding of the work to be performed.

C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job if requested. All costs associated with submission of samples shall be borne by the Contractor.

1.06 QUALITY ASSURANCE

A. All vibration isolators shall have calibration markings or some method to determine the actual deflection under the imposed load after installation and adjustment.

B. All isolators shall operate within the linear portion of their load versus deflection curves. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of at least 50% above the design deflection.

C. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%, and shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.

D. All neoprene components shall have a shore hardness of 30 to 50 ±5%, after minimum aging of (20) days or equal oven aging.

E. Substitution of internally isolated and restrained equipment in lieu of the isolation and restraints specified in this Section is acceptable provided all conditions of this Section are met. The equipment manufacturer shall provide a letter of guarantee stating that the specified noise and vibration levels will be obtained and that the seismic restraints shall be in compliance with these specifications. All costs for converting to the specified external vibration isolation and/or restraints shall be borne by the equipment manufacturer/installing contractor should submissions or installations be found to be unacceptable pursuant to the intent of this specifications.

F. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required

to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

G. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the Installing Contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

H. Manufacturer Responsibility

1. Manufacturer of vibration control equipment shall have the following responsibilities:

a. Determine vibration isolation sizes and locations.

b. Provide equipment vibration isolation as scheduled or specified.

c. Guarantee specified isolation system deflections.

d. Provide installation instructions, drawings and field supervision to ensure proper installation and performance of systems.

e. Provide certification by a licensed engineer that all mounts and restraints meet the project requirements for seismic loading.

2. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed Civil or Structural Engineer.

3. Licensed Engineers shall be licensed in the project state.

I. Contractor Responsibilities

1. The Contractor performing the work on equipment in the section shall have the following responsibilities.

a. Identify all Special inspection and Testing.

b. List control procedures within the contractor’s

organization including methods and frequency of reporting and their distribution.

c. List personnel and their qualifications exercising control over the seismic aspects of the project.

2. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.8 g load in any direction for all rigidly supported equipment, piping without failure and permanent displacement of the equipment.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe hangers.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

A. All vibration control equipment shall be delivered in containers and shall be kept in a dry and protected area.

B. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

PART 2 – PRODUCTS

2.01 ISOLATORS AND RESTRAINTS – GENERAL

A. Acceptable Manufacturers subject to compliance to specifications.

1. Mason Industries (MI)
2. Amber/Booth (AB)
3. Kinetics Noise Control (KNC)
4. Vibration Eliminator Co. (VEC)
5. Vibration Mountings & Controls (VMC)

B. The Mechanical Contractor shall provide necessary vibration isolation materials to eliminate excessive noise and vibration from being transmitted from HVAC equipment to the occupied areas of the structure, for the entire HVAC system within the building. This includes all non-structural

components such as, but not limited to, air handlers, piping, etc. (hereinafter called equipment).

C. Vibration isolation types shall be capable of accepting, without failure, determined in accordance with:

1. International Building Code 2000

2. State/Country Codes

3. Local codes enforced at the specified project location.

D. Isolators and supports shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.

E. All metal parts of vibration isolation units installed out-of-doors shall be cold dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard #14.

F. All base supported isolators shall have base plates with bolt holes for fastening the isolators to the support members.

G. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.

H. Static deflection of isolators shall be as scheduled in this Section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection under actual load. Isolators shall be selected for no less than 50% reserve deflection beyond actual operating conditions.

I. Attachment plates to be cast into housekeeping pads, concrete inserts, beam clamps, etc. that may be required for seismic compliance shall be provided by this Section.

J. Coordinate the size, location and special requirements of vibration isolation equipment and systems with other Trades. Coordinate plan dimensions with size of housekeeping pads.

2.02 VIBRATION ISOLATOR TYPES

A. Type A (Floor Spring and Neoprene)

1. The Type A spring isolator shall:

a. Have a minimum outside diameter to overall height of 0.8:1.

b. Have corrosion resistance where exposed to corrosive environment with:

1) Springs cadmium plated or electro-galvanized.
2) Hardware cadmium plated.
3) All other metal parts hot dip galvanized.

c. Have reserve deflection (from loaded to solid height) of 50% of rated deflection.

d. Have minimum 1/4" thick neoprene acoustical base pad on underside, unless designed otherwise.

e. Be designed and installed so that ends of springs remain parallel.

2. Type A isolator shall be similar to Mason Industries Type SLF.

B. Type B (Floor Spring and Neoprene Travel Limited)

1. The Type B spring isolator shall be the same as Type A with the following additional features.

a. Built-in vertical limit stops with minimum 1/4" clearance under normal operation.

b. Tapped holes in top plate for bolting to equipment.

c. Capable of supporting equipment at fixed elevation during equipment installation. Installed and operating heights shall be identical.

d. Adjustable and removable spring pack with separate neoprene isolation pad.

2. Type B isolator shall be similar to Mason Industries Type SLR.

Note: This isolator must be bolted or welded to the structure.

C. Type C (Spring Hanger Rod Isolator)

1. Spring isolator (Type A) seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.

2. Spring diameters and hanger box shall allow 30° of hanger rod movement.

3. Type C isolator shall be similar to Mason Industries Type 30 or W30.

D. Type E (Elastomer Hanger Rod Isolator)

1. Molded (minimum 1 3/4" thick) neoprene element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be minimum 0.035".

2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to (4) times the rated capacity of the element.

3. Type E isolator shall be similar to Mason Industries Type HD.

E. Type F (Combination Spring/Elastomer Hanger Rod Isolator)

1. Spring and neoprene elements in a steel retainer box with the features as described for Type C and Type E isolators.

2. Type F isolator shall be similar to Mason Industries Type 30N.

F. Type G (Pad Type Elastomer Isolator)

1. 0.75" minimum thickness, 50 psi maximum loading, ribbed or waffled design.

2. Minimum 0.1" deflection.

3. 1/16" galvanized steel plate between multiple pad layers.

4. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.

5. Type G isolators shall be similar to Mason Industries Type Super W.

G. Type H (Pad Type Elastomer Isolator)

1. Laminated canvas duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.

2. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.

3. Type H isolator shall be similar to Mason Industries Type HL.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

H. Type J (Steel Rails)

1. Steel members of sufficient strength to prevent equipment flexure during operation.

2. Height saving brackets as required to reduce operating height.

3. Type J isolator shall be similar to Mason Industries Type ICS.

I. Type K (Pipe Anchors and Guides)

1. Acoustical pipe anchor or guide, consisting of a telescopic arrangement of (2) sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.

2. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction (anchors only).

3. Allowable loads on isolation materials shall not exceed 500 psi, and the design shall be balanced for equal resistance in any direction.

4. Anchors and guides must be bolted or welded to meet seismic criteria.

5. Type K anchor shall be similar to Mason Industries Type ADA.

J. Type L (Isolated Clevis Hanger)

1. Combination clevis or rod roller hanger and a Type C, E, or F, isolation hanger.

2. System shall be precompressed to allow for rod insertion and standard leveling.

3. Type L hanger shall include Mason Industries Type CCB clevis brace.

2.03 EQUIPMENT BASES

A. All curbs and roof rails are to be bolted or welded to the building steel or concrete deck to attain acceleration criteria and shall be wind restrained for 110 mph wind loads.

B. Type B-1 (Integral Structural Steel Base)

1. The integral structural steel base shall be reinforced as required to prevent base flexure at equipment start-up and misalignment of driver and driven units. Centrifugal fan bases shall be complete with motor slide rails and shall be drilled for driver and driven units.

2. Height saving brackets shall be provided, as required, to reduce operating height and maintain 1" operating clearance under base.

3. Member depth shall be a minimum of 1/10 of the longest unsupported span.

4. Type B-1 equipment base shall be similar to Mason Industries Type M or WF.

Note: Must be used with Restraint I, II or IV.

C. Type B-3 (Spring Roof Curb)

1. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturer's curb shall not be used.

2. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Springs shall be Type A.

3. Curbs shall be thermal and sound attenuating type utilizing standard 2" roof insulation supplied and installed by the Roofing Contractor.

4. Unit shall be provided with wood nailer and flashing.

5. Curbs shall meet all NRCA Standards.

6. Curbs shall include a means of incorporating a sound barrier package, Type SBC-3 consisting of (2) layers of waterproof sheetrock furnished and installed by others.

7. Curbs installed on pitched roofs shall be factory built to compensate for elevation changes.

8. Curbs shall be similar to Mason Industries Type RSC having a minimum 3" rated static deflection.

D. Type B-5 (Roof Rail Base)

1. Rails shall be constructed from structural steel angles sized as required to prevent flexure and misalignment under load.

2. Each rail shall be the full length of the supported equipment and be welded to a series of Type B isolators. Bolt-on angle cross ties at the ends and center shall form (1) rigid platform.

3. Roof rail shall be similar to Mason Industries Type TRSLR.

2.04 FLEXIBLE PIPE CONNECTOR

A. All flexible connectors shall be installed on the equipment side of the shutoff valves, horizontal and parallel to equipment shafts whenever possible. All piping between the flexible connector and the equipment shall be independently supported off the equipment base.

B. Type FC-1 (Elastomer Connector)

1. Manufactured of nylon tire cord and EPDM, both molded and cured in hydraulic presses. Neoprene used in lieu of EPDM is not acceptable.

2. Straight connectors to have (2) spheres reinforced with a molded in external ductile iron ring between the spheres.

3. Rated at 250 psig/170°F, dropping in a straight line to 170 psig/250°F for sizes 1 1/2" to 12".

4. All sizes shall employ control cables with neoprene end fittings isolated from anchor plates by means of 1/2" bridge bearing neoprene bushings.

5. Connectors shall be installed pre-extended per manufacturer's recommendations to prevent elongation under pressure.

6. Minimum safety factory of 3.6:1 at maximum pressure ratings shall be certified by test reports. Submittals shall also include (2) test reports by independent consultants showing minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.

7. Connectors bolted to Victaulic type coupling or gage, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange.

8. Connectors for pipe size 2" and smaller shall have threaded female union couplings on each end. Larger pipe sizes shall be fitted with flange couplings.

9. Type FC-1 flexible connector shall be similar to Mason Industries Super-Flex Type MFTNC or MFTFU.

2.05 VIBRATION ISOLATION SCHEDULE

Equipment	HP	Mtng	On Grade ****				Above Grade			
			Isol	Defl	Base		Isol	Defl	Base	
Air Conditioning Condensers		Roof	---	---	---		A	2.50	B-1	
Air Conditioning Units (DX)		Flr Clg	A ---	1.0 ---	--- ---		A F	1.0 1.0	B-1 ---	
Cabinet Type Fans	To 1	Flr Clg	D ---	.50 ---	--- ---		D	See Guide	--- ---	
Cabinet Type Fans	>1	Flr Clg	A ---	1.0 ---	--- ---		A ** F	See Guide	--- ---	
Centrifugal Fans		Flr Clg	A ---	1.0 ---	B-1 ***		A** F	See Guide	B-2 ***	
Curb Mounted Equipment		Roof	---	---	---		---	---	B-5	

* Used on vertically arranged units. Rails shall be 1.5 times the unit height.
** Substitute Type B isolator for Outdoor installations.
*** Substitute Type B-2 base for floor mounted Class 2 and 3 fans.
**** "On Grade" shall mean slab on grade only.
***** Fans in all units shall be isolated in accordance with chart.

Notes:

1. "Isol", "Base" and "Restr" columns indicate letter type as appears in the specs.

2. "Mtng" refers to method of support of equipment from the structure.

3. See Guide" indicates isolator deflection selection to be taken from Deflection Guide below.

Deflection Guide	
RPM	MW Deflection
<400	3.5"
<600	2.5"
>600	1.5"

PART 3 – EXECUTION

3.01 GENERAL

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and submittal data. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

B. Design Criteria

1. All mechanical equipment such as, air handling units, etc. shall be isolated from the building structure by means of noise and vibration isolators.

2. All piping over 1" in mechanical equipment rooms and penthouses diameter shall be isolated from the building structure by means of noise and vibration isolation hangers.

3. Piping penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances around the outside, as recommended by the vibration materials manufacturer. All such penetrations shall be smokeproofed and firestopped in an approved manner as hereinbefore specified.

4. Generally, isolation facilities shall be designed to limit equipment room floor or roof loading to a maximum of 50 lbs./sq.ft. and vibration isolators shall be carefully and specifically selected for each piece of equipment.

5. Piping found to have water hammer or other objectionable vibration or noise which cannot be eliminated by proper grading or other natural means shall be braced, trapped, hung with vibration isolation hangers, equipped with air chambers or mechanical shock absorbers, flexible pipe connectors, or otherwise silenced using means as approved by the Architect.

6. Motor driven equipment which is to be isolated shall have motor mounted on the isolated equipment or shall have motor, equipment and drive mounted on a common base.

7. The Contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.

8. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.

9. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

10. Bring to the Architect's attention, prior to installation, any conflicts with other trades that will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

11. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.

12. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.

13. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.02 EQUIPMENT ISOLATION INSTALLATION

A. Equipment shall be isolated and restrained as per the vibration isolation schedule at the end of this Section.

B. Place floor mounted equipment on 4" high concrete housekeeping pads (unless detailed otherwise) properly doweled or expansion shielded to the deck to meet acceleration criteria. Anchor isolators and/or bases to housekeeping pads. Housekeeping pad concrete work shall be by Division 3. Housekeeping pads shall be sized to have a minimum of 6” of clearance all around the equipment or 12 bolt diameters, whichever is greater.

C. Additional Requirements

1. The minimum operating clearance under inertia bases shall be 2".

2. The minimum operating clearance under other bases shall be 1".

3. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.

4. The isolators shall be installed without raising the equipment.

5. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. The blocks shall be barely free and shall be removed. Remove all debris from beneath the equipment and verify that there are not short circuits of the isolation. The equipment shall be free in all directions.

6. Install equipment with flexibility in wiring.

3.03 PIPING ISOLATION INSTALLATION

A. Isolate piping outside shafts connected to rotating or reciprocating equipment and pressure reducing stations as follows:

1. All water piping in mechanical rooms.

2. Water piping within 50'-0" or 100 pipe diameters (whichever is greater) from connected isolated equipment.

B. The isolators shall be installed with the hanger box hung as closely as possible (without direct contact) to the structure.

C. The isolators shall be suspended from substantial structural members sized for a maximum deflection of L/360 at mid span, not from slab diaphragm, unless specifically permitted by the structural engineer.

D. Hanger rods shall not short circuit the hanger box.

E. Horizontal suspended water piping 1 1/4" to 2" shall be suspended by Type E isolators with a minimum 3/8" deflection. Water pipe larger than 2" shall be supported by Type F isolators with a minimum 0.75" deflection or same deflection as equipment for the first (3) locations nearest equipment, whichever is greater.

1. Type L isolators may be substituted for the above.

2. Horizontal floor and roof supported pipe shall be the same as above except use isolators Type D and Type A, respectively.

F. Vertical riser pipe supports, where required, under 2" diameter shall utilize Type H isolation.

G. Vertical riser guides, where required, shall avoid direct contact of piping with the building.

H. Pipe anchors or guides, where required, shall utilize Type K isolators.

I. Riser sway supports, where required, shall utilize (2) neoprene elements (Type G or H) to accommodate tension and compression forces.

J. Install Type FC-1 (FC-4 for refrigerant piping) flexible connectors at all connections of pipe to isolated equipment such as pumps, as shown on the drawings.

K. Install FC-2, FC-3 or FC-4 type connectors only at locations which exceed temperature or service (such as gas, fuel oil, or refrigerant) limitations of FC-1.

L. Emergency generator exhaust shall be provided with Type R isolators with a minimum deflection of 1" (larger deflections may be required). These isolators shall be closely coordinated with expansion and stress calculations and seismic restraints and movements.

3.04 INSTALLATION INSTRUCTIONS

A. Adjust all base and piping isolators as required to prevent stress transfer to equipment.

B. Set steel bases for 1" clearance between housekeeping pad and base. Set concrete inertia bases for 2" clearance. Adjust equipment level.

C. Position equipment, structural base and concrete base on blocks or wedges at proper operating height.

D. Provide all equipment and provide operating load conditions before transferring base isolation loads to springs and removing wedges.

E. Install inertia bases of type and thickness, with isolators of type and static deflection indicated.

F. Provide isolators as specified and install in accordance with the manufacturers recommendations. Seismic restraints shall not be installed until isolators are adjusted and equipment height is finalized.

G. Provide forms for 4" high housekeeping pads under all floor mounted equipment, including those with inertia blocks.

H. Install equipment with flexibility in wiring connection.

I. Verify all installed isolators and mounting system permit equipment motion in all directions.

J. Adjust or provide additional resilient restraints to flexibly limit lateral motion to 1/4" during start-up of equipment.

K. Before start-up, clean out all foreign matter between bases and equipment to prevent short circuit.

L. Install flexible pipe connectors on pipe connected to equipment supported by vibration isolation. Hook up piping to equipment and mains with spool pieces. After completion of pressure testing but prior to start-up, remove spool pieces and install flexible pipe connectors. Identify spool pieces as to equipment served and either entering or leaving.

END OF SECTION 230548

SECTION 230549 – MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS (HAGGERTY ADMINISTRATION BUILDING ONLY)

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Unless the structural drawings indicate the Seismic Design Category determined in accordance with either Section BC 1613 or ASCE 7-2010, the systems shall be designed as Seismic Design Category C, Structural Occupancy/Risk Category IV “Buildings and other structures designated as essential facilities” for seismic design as per Table BC 1604.5.

B. Provide a complete system of vibration isolation and seismic bracing for each item of HVAC piping, ductwork, and equipment as specified herein and as needed for a complete and proper installation. Provide bracing for the equipment as shown on the Drawings.

C. All piping, and equipment shall be seismically secured in accordance with Article 3.05 (with the exception of systems qualifying for exclusions as defined in Article 3.05).

D. All equipment, piping, and ductwork as noted in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

E. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

F. It is the intent of the seismic portion of this specification to keep all mechanical building system components in place during a seismic event and to prevent the release of hazardous or flammable materials contained within building mechanical systems.

G. All such systems must be installed in strict accordance with the seismic codes, component manufacturers’ and building construction standards. Whenever a conflict

occurs between the manufacturers' and construction standards, the most stringent shall apply.

H. This specification is considered to be the minimum requirements for seismic consideration and is not intended as a substitute for more stringent national, state, or local construction requirements.

I. The work in this section includes, but is not limited to the following:

1. Vibration isolation and seismic bracing for piping and ductwork

2. Equipment isolation bases

3. Flexible piping connections

4. Seismic bracing for isolated equipment

5. Seismic bracing for non-isolated equipment

J. All mechanical systems are included. Equipment buried underground is excluded but entry of services through the foundation wall is included.

1. Equipment listed below is typical and is not to be construed as complete.

AC Unit	Condensing Units	Piping

2. In general, where the failure of the equipment supports would cause a life safety hazard (to personnel or to other systems) such equipment shall be designed to resist the seismic forces.

K. All vibration isolators and seismic bracing described in this section shall be the product of a single manufacturer.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.

1.05 DEFINITIONS

A. ICC-ES: International Code Council Evaluation Service

1. ICC-ES performs technical evaluations of building products, components, methods, and materials and reports on code compliance.

B. Positive Attachment

~~1.~~ A positive attachment is defined as a cast-in anchor, a seismic drilled-in wedge anchor or anchor bolt ICC certified for cracked concrete, adhesive anchor, or a welded or bolted connection to structure. Beam clamps (2 sided or 1 sided beam clamps with restraining straps) are only allowed for hangers and are not permitted for seismic braces per ASCE 7-10 Section 13.4.6.

C. Transverse Bracing

1. Bracing which limits motion perpendicular to the centerline of the pipe or duct.

D. Longitudinal Bracing

1. Bracing which limits motion parallel to the centerline of the pipe or duct.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:

1. Product Descriptions

a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.

b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:

1) Equipment identification mark
2) Isolator type
3) Actual load
4) Static deflection expected under actual load
5) Specified minimum static deflection
6) Additional deflection-to-solid under load
7) Ratio of spring height under load to spring diameter
8) Base type
9) Seismic restraint type

c. Steel rails, steel base frames, showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.

3. Indicate isolation devices selected with complete dimensional and deflection data.

4. Show all methods of suspension and support for ceiling hung equipment.

5. Detail methods of isolation for ducts and pipes piercing walls and slabs.

6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.

7. Provide special details necessary to convey complete understanding of the work to be performed.

1.07 SUPPLEMENTAL SUBMITTALS

A. The manufacturer of vibration isolation and seismic bracing shall provide submittals for products as detailed below. These are to be submitted for record purposes only. Contractor’s Registered Professional Engineer shall sign

and seal submittals. Architect/Engineer of Record shall verify that the structural support system can support all seismic loads where the bracing is attached to the structure.

B. Descriptive Data

1. Catalog cuts or data sheets on vibration isolators and specific bracing detailing compliance with the specification.

2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic bracing.

3. Catalog cuts or data sheets on anchors.

C. Shop Drawings: Shop drawings shall be signed/sealed by the Contractor's registered Professional Engineer.

1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

2. Provide all details of suspension and support for ceiling hung equipment.

3. Where walls, floors, slabs or supplementary steel work are used for seismic bracing locations, details of acceptable attachment methods for ducts and pipe must be included and approved before the condition is accepted for installation. Bracing manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

4. Provide specific details of seismic bracing and anchors; include number, size and locations for each piece of equipment.

5. The sound power levels shall be included with data submitted for the equipment.

6. Pipe details for crossing seismic or expansion joints, bracing or attachments to dissimilar building systems or dissimilar parts of the building and service entry

D. Seismic Certification and Analysis

1. Seismic bracing calculations must be provided for all connections of equipment to the structure. Drawings and calculations must be stamped by the Contractor's registered professional engineer with at least five

years of seismic design experience in non-structural building components, licensed in New York State.

2. All bracing devices shall be tested and certified in accordance with ICC-ES AC 156 or other recognized government agency showing maximum ratings. Local NYC accelerations are to be used when computing seismic inertia forces. Where preapproved devices are not available, submittals based on independent testing shall be provided. Calculations (including the combination of tensile and shear loadings relative to seismic bracing designs) must be stamped by a registered professional engineer licensed in New York State with at least five years of seismic design experience. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode. Professional Engineer shall be retained by the Contractor at his/her expense.

3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length. All seismic bracing devices shall be designed to accept, without failure, the accelerations detailed herein acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

4. Wedge Anchor/expansion bolt – ICC-ES Reports for cracked concrete, including seismic applicability.

5. Adhesive anchor - ICC-ES Reports

6. Air Mounting Systems: natural frequency, load and damping tests performed by independent lab or acoustician

7. Riser diagrams and calculations showing anticipated expansion and contraction.

E. Submit welding certificates. Qualify welding procedures and personnel according to AWS D1.1, “Structural Welding Code-Steel.”

1.08 SUPPLEMENTAL QUALITY ASSURANCE

A. Manufacturer’s Qualifications

1. Isolator/Bracing manufacturer shall be regularly engaged in the manufacturing of vibration isolating

and seismic bracing materials, whose products have been in satisfactory use in similar service for not less than five years.

B. Seismic Engineer's Qualifications and Duties

1. The Contractor shall engage the services of a third party Registered Professional Engineer (not a direct employee), who shall have a minimum of five years seismic design experience in non-structural building components and shall be licensed in New York State.

a. For combination vibration isolator/seismic restraints, the Contractor's registered professional engineer shall determine vibration isolation and seismic bracing sizes and locations and provide field supervision and inspection to ensure proper installation and performance.

b. For separate seismic restraints not combined with vibration isolators, Contractor's registered professional engineer shall determine seismic bracing sizes and locations and provide field supervision and inspection to ensure proper installation and performance.

c. The Contractor's registered professional engineer shall prepare and sign and seal shop drawings of the seismic design.

1.09 SUPPLEMENTAL CODE AND STANDARDS REQUIREMENTS

A. Chapter 16 of the Building Code

B. ASCE 7–2010 Minimum Design Loads for Buildings and Other Structures.

C. ASHRAE: Practical Guide to Seismic Restraint, 1999

D. ANSI/SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition, 2008.

1.10 RELATED WORK

A. Supplementary Support Steel

1. Contractor shall supply supplementary support steel for all equipment, piping, etc. including roof mounted equipment, as required or specified.

B. Attachments

1. Contractor shall supply bracing attachment plates cast into housekeeping pads, concrete inserts, etc. in accordance with the requirements of the vibration vendor's calculations.

1.11 SEISMIC ACCELERATION LEVELS

A. The horizontal accelerations (in g's) are defined as the ratio of the horizontal seismic force to the weight of the element being braced. For purposes of calculating design seismic forces in non-building structures, the weight shall also include all normal operating contents for items such as tanks, vessels, and piping.

B. Seismic bracing shall be designed for seismic effects/accelerations as per Chapter 16 of the Building Code and ASCE 7-2010. Refer to Article 3.05 "Seismic Bracing/Restraint of HVAC Piping, Equipment and Ductwork" for description of required items to be designed and constructed to seismic requirements.

1. Seismic Design Category and Seismic Accelerations are indicated on the Structural Drawings.

2. Component Importance Factors are indicated in the "Component Seismic Importance Factors Ip" schedule on the Mechanical (HVAC) Drawings. Per Section BC 1604.5.2, Importance Factors for seismic loads shall be determined in accordance with BC Table 1604.5.2 based on the Structural Occupancy Category/Risk Category assigned in accordance with BC Table 1604.5.

PART 2 – PRODUCTS

2.01 ISOLATORS AND RESTRAINTS – GENERAL

A. Acceptable Manufacturers subject to compliance to specifications.

1. Mason Industries (MI)
2. Amber/Booth (AB)
3. Kinetics Noise Control (KNC)
4. Vibration Eliminator Co. (VEC)
5. Vibration Mountings & Controls (VMC)

2.02 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the manufacturers specified.

B. Failure is defined as the discontinuance of any attachment point between equipment and structure, vertical permanent deformation greater than 1/8″ and/or horizontal permanent deformation greater than 1/4″.

2.03 PRODUCT DESCRIPTIONS

A. Vibration Isolators

1. Manufacturers:

a. Mason Industries Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls/Korfund

d. International Seismic Application Technology (ISAT)

2. Elastomeric isolator pads: Oil and water resistant elastomer, arranged in single or multiple layers, molded with a non-slip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment. The neoprene pads shall be sized for a load of 50 pounds per square inch and shall be a minimum of 5/16″ thick.

a. Material: bridge bearing neoprene, complying with AASHTO M 251.

b. Durometer rating and number of layers as required for stiffness and deflection based on supported load.

3. Elastomeric Mounts: Double deflection type, with molded oil resistant rubber or neoprene isolator elements with factory drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color code or otherwise identify to indicate capacity range.

a. Durometer rating as required for stiffness and deflection based on supported load.

4. Spring Isolators: Freestanding, laterally stable, open spring isolators.

a. Outside spring diameter not less than 80% of the compressed height of the spring at rated load.

b. Minimum additional travel shall be 50% of the required deflection at rated load.

c. Lateral stiffness shall be more than 80% of the rated vertical stiffness.

d. Overload capacity: Support 200% of rated load, fully compressed, without deformation or failure.

e. Baseplates: Factory drilled for bolting to structure and bonded to 5/16" thick rubber isolated pad attached to baseplate underside. Baseplates shall limit floor load to 50 psig.

f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

5. Restrained Spring Isolators: Freestanding, steel, open spring isolators with seismic restraint.

a. Housing: Steel with resilient vertical limit stops to prevent spring extension due to wind loads or if weight is removed; factory drilled baseplate bonded to 5/16" thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

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

c. Minimum Additional Travel: 50% of the required deflection at rated load

d. Lateral Stiffness: More than 80% of the rated vertical stiffness

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

f. Housing shall be designed to resist all seismic forces. Mountings shall be tested and certified in accordance with ICC-ES AC 156 for the maximum certified horizontal and vertical load ratings.

6. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

a. Housing: Ductile iron or steel housing to provide all directional seismic restraint.

b. Base: Factory drilled for bolting to structure.

c. Snubbers: Vertically adjustable to allow a maximum of 1/4" travel before contacting a resilient collar.

d. Mountings shall be tested and certified in accordance with ICC-ES AC 156 for the maximum certified horizontal and vertical load ratings.

7. Elastomeric Hangers: Double-deflection type, with molded oil resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color code or otherwise identify to indicate capacity range.

8. Spring Hangers: Combination coil spring and elastomeric insert hanger with spring and insert in compression.

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

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

   c. Minimum Additional Travel: 50% of the required deflection at rated load.

   d. Lateral Stiffness: More than 80% of the rated vertical stiffness.

   e. Overload capacity: Support 200% of rated load, fully compressed, without deformation or failure.

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

9. Spring Hanger with Vertical Limit Stop: Combination coil spring and elastomeric insert hanger with spring and insert in compression and with a vertical limit stop.

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

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

c. Minimum Additional Travel: 50% of the required deflection at rated load

d. Lateral Stiffness: More than 80% of the rated vertical stiffness

e. Overload Capacity: Support 200% of the rated load, fully compressed, without deformation or failure

f. Elastomeric Element: Molded, oil resistant neoprene

g. Adjustable Vertical Stop: Steel washer with neoprene washer seismic “up-stop” on lower threaded rod.

10. Thrust Limits: The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc. or approved equal.

11. Resilient Pipe Guides: Telescopic arrangement of two steel tubes separated by a minimum of 1/2” thick 60 durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

B. Air Mounting Systems

1. Manufacturers:

a. Mason Industries

b. Vibration Eliminator Co., Inc.

c. International Seismic Application Technology (ISAT)

2. Air Mounts: Freestanding, single or multiple, compressed-air bellows.

a. Assembly: Upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene bellows

b. Maximum Natural Frequency: 3Hz

c. Operating Pressure Range: 25 to 100 psig

d. Burst Pressure: At least three times the manufacturer’s published maximum operating pressure

e. Leveling Valves: Minimum of three required to maintain leveling within plus or minus 1/8”.

f. Submittals shall include natural frequency, load and damping tests performed by independent lab or acoustician.

3. Restrained Air Mounts: Housed Compressed Air Bellows

a. Assembly: Upper and lower sections connected by a replaceable flexible nylon reinforced neoprene bellows and spring, with angle iron frame having vertical limit stops and channel section top with leveling adjustment and attachment screws.

b. Maximum Natural Frequency: 3 Hz

c. Operating Pressure Range: 25 to 100 psig

d. Burst Pressure: At least three times the manufacturer’s published maximum operating pressure

e. Leveling Valves: Minimum of 3 required to maintain leveling with plus or minus 1/8”.

f. Housings shall be designed to resist all seismic forces.

C. Seismic Bracing/Restraint Devices

1. Manufacturers:

a. Mason Industries, Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls/Korfund

d. International Seismic Application Technology (ISAT)

2. Restrained Elastomeric Mount: Bridge bearing neoprene mountings shall have a minimum static deflection of 0.2″ and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposed molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications. Mountings shall be tested and certified in accordance with ICC-ES AC 156 for the maximum certified horizontal and vertical load ratings. Mountings shall be Mason Industries Type BR or approved equal.

3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve shall prevent the sheet metal from cutting into the neoprene. Panel holes shall be enlarged as required. Neoprene elements shall pass over the bushing to cushion the back panel horizontally. A steel disc shall cover the inside neoprene element and the inner steel sleeve shall be elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies shall be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc. or approved equal.

4. Washer/Bushing: A one-piece molded bridge bearing neoprene washer/bushing shall be used. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc. or approved equal.

5. Seismic cable bracing shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional bracing. Cables shall be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel

assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables shall not be allowed to bend across sharp edges. Cable assemblies shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified load ratings. Cable assemblies shall be secured with Mason Industries Type SCB (or approved equal) at the ceiling and at the clevis bolt. Mason Industries Inc. type SCBH (or approved equal) shall be used between the hanger rod nut and the clevis. Mason Industries type SCBV (or approved equal) shall be used if cable is clamped to a beam.

6. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc. or approved equal.

7. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each bracing location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be tested and certified in accordance with ICC-ES AC 156. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc. or approved equal.

8. Pipe clevis cross bolt braces are required in all bracing locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall be tested and certified in accordance with ICC-ES AC 156. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc. or approved equal. See Figure 3-9 of ASHRAE Practical Guide to Seismic Restraint, 1999.

9. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" thick. Rated loadings shall not exceed 1000 psi. A minimum air gap of 1/8" shall be incorporated in the

snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1225 as manufactured by Mason Industries, Inc. or approved equal.

10. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more that 1/4". Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" deflection in the x, y and z planes. Snubbers shall be tested and certified in accordance with ICC-ES AC 156 verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-1011 as manufactured by Mason Industries, Inc. or approved equal.

11. Expansion/Screw/Adhesive Anchors:

    a. Anchors in concrete or masonry shall be in accordance with ASCE 7-10 Section 13.4.2.

        1) As a minimum, all anchors exposed to weather or embedded in masonry are to be Type 316 stainless steel.

        2) Anchors installed in concrete shall have current ICC-ES listing for performance in cracked concrete as per Section BC 1912 of the 2014 NYC Building Code.

            a) Wedge Expansion and Undercut Anchors/ expansion bolts/screw anchors shall have an ICC-ES Evaluation Service Report (ESR) issued in accordance with ICC-ES AC 193 for use in cracked

concrete, including seismic applicability loading.

b) Adhesive anchors in concrete shall have an ICC-ES Evaluation Service report (ESR) issued in accordance with ICC-ES AC 308 for use in cracked concrete, including seismic applicability loading, and pursuant to the Office of Technical Certification and Research (OTCR) Building Bulletin 2009-019.

12. Stud wedge anchors shall be epoxy adhesive based and manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall be tested and certified in accordance with ICC-ES AC 156 verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc. or approved equal.

13. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be epoxy adhesive based and manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall be tested and certified in accordance with ICC-ES AC 156 verifying their allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc. or approved equal.

14. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar® tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1½" may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi up to 170oF with a uniform drop in allowable pressure to 215 psi at 250oF in sizes through 14"; 16" through

24" single sphere minimum ratings are 180 psi at 170oF and 150 psi at 250oF. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.

a. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.

b. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be by Mason Industries (or approved equal) SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc. (or approved equal).

15. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

a. Flanged

1) 3″x14″, 4″x15″, 5″x19″, 6″x20″, 8″x22″, 10″x26″, 12″x28″, 14″x30″, 16″x32″

b. Male Nipples

1) 1/2″x9″, 3/4″x10″, 1″x11″, 1¼″x12″, 1½″x13″, 2″x14″, 2½″x18″

c. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses

shall be type BSS as manufactured by Mason Industries, Inc. or approved equal.

D. Vibration Isolation Equipment Bases

1. Manufacturers (as listed, or approved equal)

a. Mason Industries Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls/Korfund

d. International Seismic Application Technology (ISAT)

2. Steel base: Integral structural steel base shall be provided. Independent steel rails are not permitted on this project. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

a. Design Requirements: Lowest possible mounting height with not less than 1" clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

b. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A 36M. Bases shall have shape to accommodate supported equipment.

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

3. Equipment anchor bolts with bottom plates and pipe sleeves shall be preset.

PART 3 – EXECUTION

3.01 PREPARATION

A. For vibration isolation and seismic bracing equipment installed indoors, all metal parts, including rails and bases, shall be painted at the factory with one coat of primer paint and one coat of aluminum paint. Other means

or rust resisting painting may be accepted, subject to prior approval.

B. Vibration isolation and seismic bracing equipment installed outdoors shall have all steel parts hot dipped galvanized, all bolts cadmium plated, and all springs cadmium plated and neoprene coated.

C. Vibration isolation and seismic bracing equipment installed outdoors shall be designed and installed to resist wind loads in accordance with the Building Code.

3.02 SUPPLEMENTAL INSTALLATION

A. At each equipment location, provide the required deflection under the imposed load to produce uniform loading and deflection even when equipment weight is not evenly distributed. Springs shall be designed and installed so that the ends remain parallel during and after spring deflection to operating height. Jack inertia blocks and bases into position and wedge in place before spring loading; leveling bolts shall not be used as jacking screws. After equipment is in place and springs are loaded through leveling bolts, remove wedges and jacks. Isolators shall be suitable for the lowest operating speed of the equipment. Vertical limit stops shall be out of contact during normal operation.

B. Where the floor is waterproofed or finished with waterproof cement, install seismic bracing and vibration isolation in such manner that the waterproofing is not damaged.

C. Isolation equipment shall be in accordance with the following table:

Lowest RPM	Inches Deflection (Min.)	% Efficiency (Min.)	Type
1750 & over	.25	95	Single Neoprene- in-shear
1200-1749	.50	95	Double Neoprene-in-shear
1000-1199	.75	95	Spring
570-999	1.25	90-95	Spring
520-569	1.5	90	Spring
330-519	2.0	80-90	Spring
Up to 329	3.5	80	Spring

D. Install combination spring and double deflection neoprene position hangers on all refrigeration piping located in the Equipment Room.

E. The minimum horizontal isolation required for equipment piping shall be installed as follows:

1. Metal piping connected to power driven equipment shall be resiliently supported from or on the building structure from the power driven equipment for a distance of the maximum of 50 pipe diameters or the first three pipe hangers, whichever is the longest length. The isolators shall be pre-compressed spring and neoprene type hangers. Pre-compressed spring and neoprene type hangers must also be used in all transverse braced isolated locations. Horizontal runs in all other locations throughout the building shall be isolated by spring and neoprene hangers that need not be pre-compressed. Floor supported piping shall rest on isolators such as Mason Industries SLR spring mounts (or approved equal).

a. The resilient isolators shall have a minimum static deflection of 1″ for all piping with a 4″ or larger in actual outside diameter and 1/2″ (12.7 mm) for piping with less than 4″ in actual outside diameter.

b. Piping connected to fluid pressure-reducing valves shall be resiliently isolated for a distance of 50 pipe diameters from pressure reducing valves and isolators shall provide a minimum static deflection of 1/2″.

F. Ceiling Suspended Packaged HVAC Units with Compressors: Equipment such as heat pumps, AC units, or similar equipment, that is suspended from a structure shall be resiliently supported from or on the building structure. Vibration isolators shall have a minimum isolation efficiency of 90 percent at the lowest disturbing frequency.

3.03 SCHEDULE

A. Provide vibration isolation supports for HVAC equipment as indicated in this schedule. Contractor shall submit a schedule for approval by Engineer of Record indicating the type of support for each item of Plumbing & Drainage Equipment and each item of Electrical Equipment.

Equipment	Location	Type of Support
Air Handling Unit	Overhead supported Hangers	spring and double deflecting neoprene
Pipe, refrigerant	Equipment room	spring and D.D.* hanger

*D.D. = Double Deflecting

3.04 GENERAL

A. All vibration isolators and seismic bracing systems shall be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic bracing shall not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any equipment, piping, or duct that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor’s expense.

G. Bring to the architects/engineers attention any discrepancies between the Contract Documents and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor’s expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials.

1. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:

a. Flanges of structural beams.

b. Upper truss cords in bar joist construction.

c. Cast in place inserts, expansion bolts/ wedge type drilled-in concrete anchors/adhesive anchors.

I. Cable bracing shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

J. Cable assemblies are installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.

K. At locations where cable or seismic solid brace restraints are located, the gravity support rods must be braced when necessary to accept compressive loads by clamping with steel angles that are sized to prevent the buckling of the rods. A minimum of three ductile iron clamps shall be used. Welding of support rods is not acceptable.

L. At all locations where cable or seismic solid brace restraints are attached to pipe clevises, the clevis cross bolt must be reinforced with braces.

M. Drill-in concrete anchors for ceiling and wall installation shall be provided and female wedge type anchors shall be used for floor mounted equipment.

N. Vibration isolation manufacturer shall furnish integral structural steel bases (or inertia bases) as required. Independent steel rails are not permitted.

O. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed support capabilities.

P. Air handling equipment shall be protected against excessive displacement that results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be used.

Q. Locate isolation hangers as near to the overhead support structure as possible.

R. When the equipment sound levels exceed the specified noise criteria, removable acoustic enclosures, alterations to the equipment, or other approved means shall be provided to reduce equipment sound level to that specified.

3.05 SEISMIC BRACING/RESTRAINT OF HVAC PIPING, EQUIPMENT

A. Per ASCE 7-10, for Seismic Category C, seismic bracing shall be provided for all HVAC equipment and distribution systems with Ip=1.5.

B. For HVAC equipment and systems in Seismic Design Category C with Ip=1.0, seismic bracing shall be provided unless the

distance, weight and size exceptions as defined in ASCE 7-2010 as modified below are met.

C. Seismic braces are not required provided that the component importance factor, Ip, is equal to 1.0. (Section 13.1.4 Exception 5.)

A. Seismically restrain piping with cables if isolated. Cables or seismic solid brace restraints may be used on unisolated piping.

B. Transverse piping bracing shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

C. Longitudinal bracing shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

D. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal bracing provided they have a capacity equal to or greater than the bracing loads in addition to the loads induced by expansion or contraction.

E. Transverse bracing for one pipe section may also act as a longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.

F. Hold down clamps must be used to attach pipe to all trapeze members before applying bracing in a manner similar to clevis supports.

G. Branch lines may not be used to brace main lines.

H. For Seismic Design Categories C and D, restrain components with Ip=1.0 located above or in proximity to components with Ip=1.5 that could damage components with Ip=1.5.

3.02 BUILDING SEISMIC OR EXPANSION JOINTS

A. Provide building seismic or expansion joints in accordance with ASCE 7-10 Section 13.6.3.3. Provide pipe offsets, loops, and guides; pipe ball joints; pipe swing joints and expansion joints utilizing grooved pipe; flexible braided stainless steel pipe loops and flexible braided bronze pipe loops; or other flexible joints capable of accommodating seismic displacements where pipes pass through building seismic or expansion joints, the width of which are shown on the Structural Drawings. Refer to the ANSI/SMACNA

Seismic Restraint Manual, 3rd Edition, 2008. Reference is also made to Figs. 7-19 and 7-20 of the 1999 ASHRAE Practical Guide to Seismic Restraint for ductwork systems that cross building seismic joints. A rigid piping or duct system shall not be braced or attached to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake without providing the above mechanisms to absorb the movement.

B. Joints, offsets, loops, anchors and guides shall accommodate bending, torsion, compression and extension. The Contractor's registered professional engineer shall detail all piping and duct joints that pass through building seismic or expansion joints. The Contractor's registered professional engineer shall also detail all piping and duct joints required as a result of bracing or attachment to dissimilar building systems or dissimilar parts of the building.

3.03 FIELD QUALITY CONTROL

A. Cooperate with the owner and provide all required access to facilitate all testing and inspection related to the Special Inspection.

B. On completion of the vibration isolation system herein specified, the representative of the vibration isolation manufacturer shall inspect the completed systems and report in writing any installation error, improperly selected isolation devices, or any other faults that could affect performance.

C. The Contractor's Engineer for combination seismic restraints/vibration isolators shall make field inspections to ensure the restraint/isolator construction is in accordance with his/her design documents and shop drawings. The Contractor's Engineer for separate seismic restraints not combined with vibration isolators shall make field inspections to ensure the restraint construction is in accordance with his/her design documents and shop drawings.

3.04 EQUIPMENT VIBRATION ISOLATOR AND SEISMIC BRACING/RESTRAINT SCHEDULE

A. Equipment vibration isolation and seismic bracing schedule shall be submitted by the Contractor's registered professional engineer. Schedule shall list all equipment with associated isolators and seismic bracing as well as the static deflections of each piece of equipment when mounted on its isolators. Contractor's registered professional engineer shall indicate on the schedule if equipment only requires seismic bracing, requires seismic

bracing as well as vibration isolators, mounted on steel dunnage, directly mounted to pad or mounted on concrete filled inertia base.

END OF SECTION 230549

SECTION 230719 – HVAC PIPING INSULATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all piping insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete insulated system for all piping, valves, fittings, joints, offsets and flanges specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

C. Hard insulation material shall be provided at all hangers.

D. Insulate the following:

1. All scheduled piping, all valves, fittings, elbows, flanges and accessories.

2. All piping exposed to weather including provision of additional weatherproof jacket.

3. Piping jacket covers.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Section of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM C 534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

2. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

3. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

4. ASTM E 96 – Standard Test Methods for Water Vapor Transmission Materials.

5. NFPA 225 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

6. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

7. ANSI/ASHRAE 90.1 – Energy Conservation in New Buildings.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for Additional Requirements.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

D. Installation Graphic Details.

1.06 QUALITY ASSURANCE

A. All insulation materials, finishes, coatings, cements, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

B. Piping insulation for the various piping systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system

of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating 25 (No Exceptions)

2. Smoke Developed Rating: 50

C. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

D. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

E. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

F. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

G. Where insulation is specified for piping, insulate similarly all connections, vents, drains and any piping connected to system subject to heat loss or gain. Do not cover vent petcocks, cleanouts or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

1.07 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

1.08 DELIVERY, STORAGE AND PROTECTION

A. Accept materials on site, labeled with manufacturer’s identification, product density and thickness.

B. All materials shall be stored in a dry area free from moisture and debris.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 – PRODUCTS

2.01 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Insulation:

1. Manville Corporation.
2. Owens-Corning Fiberglass Corporation.
3. Armstrong World Industries, Incorporated.
4. Certainteed Corporation.
5. Knauf

B. Mastics and adhesives:

1. Childers Products Company.
2. H. B. Fuller Company, Foster Products Division.
3. 3M Company Adhesives, Coatings and Sealers.
4. Armstrong World Industries, Incorporated.
5. Ruston Plant.
6. Chicago-Mastic
7. Insul-Coustic
8. St. Clair Rubber
9. Vimasco
10. Baldlwin-Ehret-Hill

C. Pipe insulation of hanger and support:

1. Pipe Shields, Inc.
2. Rilco Manufacturing Company.

3. Elcen Metal Products Company.

4. Power Piping Company.

5. NPS Industries.

D. PVC fitting covers:

1. Manville, Corporation.

2. Ceel-Co.

3. Certainteed, Corp.

4. Cell Co. Plastics

2.02 GENERAL

A. Adhesives and insulation materials: Composite fire and smoke hazard ratings maximum 25 for flame spread and 50 for smoke developed for pipe insulation. Adhesives to be waterproof when cured.

B. The installation of thermal insulating materials coverings and coatings containing asbestos fibers is forbidden.

C. Insulation shall not be chemically reactive to the metal over which it is applied. Insulation installed on steel shall be neutral or slightly alkaline. Insulation installed on aluminum shall be neutral or slightly acidic.

2.03 MATERIALS AND COMPONENTS

A. Fiber Free Elastomeric Foam: Closed-cell, sponge- or expanded-rubber materials. Comply with MIL-A-24179A, Type II, Class I, ASTM C 534, Type I for tubular materials. Thermal conductivity of 0.25 at 75°F mean temperature.

B. Additional insulation jacket:

1. ADJ-1: 20 mil PVC jacket suitable for all types of paint with UV inhibitor. Similar to Manville Zeston 25/50 white.

C. Adhesives:

1. Code ADH-1: Fast-drying rubber base adhesive for flexible elastomeric insulation. Similar to Armaflex 520.

D. Mastics:

1. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.

2. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.

3. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

E. Tie wire:

1. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

F. Banding:

1. 3/8-inch x 0.02 inch type 304 stainless steel for pipe insulation.

2. 3/4-inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

G. Wire mesh:

1. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.

2. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

H. Tape:

1. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

I. Staples:

1. Staples shall be galvanized clad outward clinching insulation staples.

PART 3 – EXECUTION

3.01 PREPARATION

A. No insulation shall be applied until the surfaces of the equipment to be insulated are thoroughly cleaned and until pipes and equipment to be insulated have been leak tested and proven tight and accepted by THE ENGINEER

B. Insulation shall not be applied to piping or equipment until authorization is given to the Contractor by the Engineer. Contractor shall submit a request for authorization. If any insulation is applied without first obtaining authorization, it will be the Contractor's responsibility to remove the insulation and apply it again if so directed.

C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

D. The execution of the insulation work shall be in strict accordance with the best practices of the trade and with the specifications.

E. The insulation shall be handled and applied in a manner that will not adversely affect its structural or insulating properties.

F. The installation instructions provided by the insulation material manufacturer of all materials specified in this Section shall be followed when installing these materials. Where the specifications are in conflict with manufacturers' instructions, such conflicts shall be brought to the attention of the ENGINEER for a decision.

3.02 PIPING INSULATION INSTALLATION

A. Ensure insulation is continuous through interior walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed. Insulation on all cold surfaces where vapor barrier jackets are specified must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, and other heat conductive parts that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

B. Insulate fittings, valves, unions, flanges, and strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with PVC or aluminum end caps.

C. Where two sections of pipe insulation butt together provide a 3-inch-wide butt strip of same facing material as adjacent insulation facing. Adhere neatly in place using adhesive ADH-3.

D. All pipe elbows shall be insulated with elastomeric insulation. Coat with MAS-1 mastic and reinforce with ADJ-1 over insulated elbow exception. Tape elbow to adjoining insulation.

E. All valves and fittings shall be insulated with elastomeric insulation. Coat with MAS-1 mastic and reinforce with ADJ-1 over insulated elbow exception. Tape elbow to adjoining insulation.

F. Fittings on pipe lines in finished and concealed areas shall be insulated with elastomeric insulation. Coat with MAS-1 mastic and reinforce with ADJ-1 over insulated elbow exception. Tape elbow to adjoining insulation.

G. On cold pipes the fittings shall be finished with (2) coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent pipe insulation. Hot pipes shall be finished in a similar manner except the mastic need not be of the vapor barrier type.

H. Insulation shall cover the entire surface of the fittings and bodies of the valves up to and including the bonnets, and to the valve stuffing box studs, bolts, or nuts. Mastic shall be trowelled to a smooth and well-shaped contour compatible with adjoining pipe insulation jackets as specified.

I. Use ADJ-1 covers over fittings and flanges everywhere.

J. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship on all joints of all piping.

K. All instrument connections for thermometers, thermocouples, gauges, test connections, flow meters, etc., on insulated pipes, vessels, or equipment shall be insulated with elastomeric insulation. The insulation shall be shaped at these connections by tapering it to and around the connection with vapor barrier adhesive, applicable mastic, or caulking compound.

PART 4 – SCHEDULES

4.01 PIPING INSULATION SCHEDULE:

A. For the purpose of the following table, following are considered to be the pressure and temperature ranges:

1. Refrigeration Liquid Line, Condensation Drains – 40-60 Deg. F

2. Refrigeration Suction Line- 34- 60 Deg. F

Service	Type Insulation and Thickness (Inches)	Additional Jacket*	Thicknesses (inch.)
Condensation Drains (Indoor)	Flexible Elastomeric		0.5
Refrigerant Suction Line, Liquid Line (Indoor)	Flexible Elastomeric	ADJ-1	0.5
Refrigerant liquid and suction line (Outdoor)	Flexible Elastomeric	ADJ-1	1.0

*Including elbows, fittings, valves, complete system.

END OF SECTION 230719

SECTION 230900– DIRECT DIGITAL/AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

A. Furnish and install a complete system of automatic temperature controls to make a fully operational and controllable building HVAC system.

B. The system shall be all electric DDC (direct digital control).

C. All system components shall be installed in accordance with local and State codes.

D. Secure all permits and local/State approval for all components and installation as specified under this Section.

E. Provide complete commissioning for all control system components and sequences of operation.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Section 23 81 26 – Split System Air Conditioners

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NFPA 70 – National Electric Code.

2. UL-916 – Energy Management Systems.

3. UL-873 – Temperature Indication and Regulating Equipment.

4. FCC; Part 15, Subpart J – Class A computing Equipment.

5. UL-864 – Fire and Smoke Control.

1.05 SYSTEM DESCRIPTION

A. Furnish and install, as hereinafter specified, a direct digital/ electric/electronic temperature control Building Management System (BMS). The system shall be fully integrated with the existing Building Management System of the serving rest of the systems in the building.

B. The contractor shall engage the services of the existing BMS system manufacturer/service provider serving the building for procurement, installation, wiring, logics and programming of the systems installed in this project for seamless integration with the existing BMS system. All system controls shall be in full compliance with the requirements of the existing BMS system vendor.

C. The contractor shall provide all required BMS system components in the equipment installed in the project either factory installed or field installed with the full written concurrence of the project equipment manufacturer for equipment installation, operation and warranty sustenance.

D. The system shall be comprised of a network of various independent BACNet Interface and BACNet Digital Controllers, electric/electronic control equipment, thermostats, sensors, controllers, dampers, actuators, panels and related hardware, software and other accessory equipment, along with a complete system of electrical control wiring, and software generation to fill the intent of the specifications and provide for a complete and operable system.

E. The control systems shall be modified by competent control mechanics and electricians regularly employed by the manufacturer of the control equipment. All control equipment shall be the product of one (1) manufacturer and all components shall be capable of interfacing with the HVAC equipment.

F. The Contractor shall submit a copy of the manufacturer’s standard software and firmware licensing agreement for the owner’s signature. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer’s license agreement, but shall protect

manufacturer's rights to disclosure of trade secrets constrained within such software.

A. All products of the Building Automation System shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems

2. UL-873; Temperature Indication and Regulating Equipment UL-864; Subcategories UUKL, QVAX, UDTZ; Fire and Smoke Control Systems

3. FCC; Part 15, Subpart J, Class A Computing Devices

B. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Codes.

1. This specification makes numerous references to BACnet and BACnet devices. In all instances these references are acknowledged to be registered trademarks.

2. All terminal unit controllers shall be networked into BACnet network (and be native BACnet or be provided with communication cards).

3. Provide controllers in accordance with the required sequence of operation as described in Part 4. When BACnet controls are provided, the Contractor shall provide BACnet devices/controllers with application source code, device resource files (DRF), and external interface files (XIF). A licensed copy of each software toolset required to install and commission the devices/controllers shall be provided to the owner.

4. The Contractor shall provide all BACnet wiring from the AC Units, fans including all conduit, enclosures, for all BACnet DDC points listed in the point lists and as shown on the contract drawings.

5. Contractor shall submit their proposed system architecture to the Engineer for their review and approval.

1.06 SUBMITTALS

B. See Section 230500 and General Conditions for additional requirements.

C. Product Data: Provide data for system component and software module.

D. Shop Drawings:

1. Indicate trunk cable schematic showing programmable control unit locations and trunk data conductors.

2. List connected data points, including connected control unit and input device.

3. Indicate all system graphics for all controlled systems including all air handling systems, hydronic pumping systems, monitored systems, data (connected and calculated) point addresses and operator notations.

4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems and interconnections.

5. Indicate description and sequence of operation of operating, user and application software

6. Develop and provide emergency, fire, smoke management control and device response matrices in an MS Excel spreadsheet format.

7. Show pneumatic/electronic ranges for each valve, damper, inlet vanes actuators etc., (i.e. 8-13 psi or 0-10 vdc).

8. Show calculated air consumption for all pneumatically controlled devices and compressor sizing data. This does not release Contractor from providing specified compressor.

9. Show system network architecture with high level and lower level transmission and communications network to include all addressable controllers, communication repeaters, routers, gateways, operator workstations, terminal connection ports, network servers, printers, etc.

10. All control logic and controllable components shall be depicted and identified within each matrices developed.

E. Manufacturer's Installation Instructions: Indicate manufacturer's installation instructions for all manufactured components.

F. Project Record Documents: Record actual locations of control components, including control units, thermostats and sensors, junction boxes, transformers, box addresser.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittal data in final "Record Documents" form.

3. All start-up/checkout documentation shall be initial and signed by the on-site control technician with intimate knowledge of the project.

4. Provide start-up/checkout documentations for DDC controllers connected to the existing BMS network. Documentation shall include all controller points used and unused (spare). Furthermore, all final settings, calibration, coefficient values, K factors, spanning, actual spring ranges, etc., shall be indicated for all active points in use.

5. Revise all control sequence for all controlled sequences for operation. Sequence of operation that restate the Design Engineer's sequences will not be acceptable. Complete details will be given within the sequences of operation provided by the Contractor. Details shall include but not limited to the following items control strategy, timers, delays, logic sequencing, start/stop, end devices involved, sensors involved, set points, globally commanded values, shared data between panels and controllers.

G. Operations and Maintenance Data:

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.

2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

3. Include inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

1.07 QUALITY ASSURANCE

B. Perform work in accordance with NFPA 70 and Divisions 26, 27 and 28 specifications.

C. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed within the State in which the project is located.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of documented experience.

E. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum ten (10) years of documented experience and approved by manufacturer.

F. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.08 WARRANTY

A. See Section 230500 and General Conditions for additional requirements.

B. The system specified herein and shown on the drawings shall be guaranteed to be free from original defects in both material and workmanship for a period of twelve (12) months of normal use and service, excepting damages from other causes. This guarantee shall become effective starting the date the Contract work is accepted as complete by the Owner and in accordance with the General Provisions/Conditions.

C. Provide five (5) year manufacturer’s warranty for field programmable micro-processor-based units.

D. Submit manufacturer’s warranty and ensure forms have been filled out in Owner’s name and registered with manufacturer.

1.09 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for one (1) year from Data of Substantial Completion.

B. Provide two (2) complete inspections during the first year, one (1) in each season, to inspect, calibrate and adjust controls as required and submit written reports.

1.10 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software shall enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

1.11 MANFUCATURER

A. The existing control systems at the campus are as follows:

1. Carrier Corporation

2. Siemens Corporation

B. The control systems shall be provided from one of the above two manufacturers only, whose system serves the building where the work is performed. No other manufacturer's system will be acceptable.

C. Contractor shall engage the services of the existing control manufacturers for the installation, integration and programming of the system installed in the project with the campus control system.

PART 2 - PRODUCTS

2.01 ELECTRIC LOW VOLTAGE WIRING

A. Furnish all labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automatic system (DDC).

B. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified, shall be provided by the Contractor, unless specifically shown on the Electrical drawings or called for in the Electrical specifications.

C. Furnish all labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the DDC.

D. All wiring throughout shall be concealed where possible.

E. All conduit used shall be Electrical Metal Tubing (EMT), 3/4" minimum size or larger. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes. Conduit shall be rigid up to 12′-0″ AFF in mechanical rooms.

F. Conduit shall never to be relied upon for a fault current and safety ground return conductor.

G. The ground system shall not be used as a current carrying conductor except for faults and noise suppression. The grounding system shall be used to control noise and transients which might affect the operation of the automation system. As such, the ground requirements shall be in excess of a grounding system used solely for physical protection minimum (Code requirement).

H. In all cases, the bond to ground shall be as short as possible. A ground point shall be derated by one (1) point (in order of preference) for each 50′-0″ of conductor run between it and the automation equipment to be grounded. Therefore, a water pipe bond located 10′-0″ away will be preferable to a structural steel bond located 150′-0″ away.

I. Set screw connectors shall be galvanized or plated steel. White metal cast type will not be permitted.

J. Flexible conduit shall be used at field devices, i.e., pressure switches, flow switches, temperature devices, etc. Convolutions shall be steel, interlocked continuously. Aluminum will not be permitted. "Liquidtight" shall be used in wet locations. Flexible connector shall be a minimum of 18" long.

K. Only core drilling is permitted to pierce the floors in the electrical closets and elsewhere. The use of water for drilling shall be controlled by a suitable vacuum system, using proper dams to prevent damage to floors below. The Contractor shall be responsible for providing a suitable sleeve in all core drilled holes as specified herein.

L. All wiring shall be run in EMT and as noted below:

1. Sensor to Panel (Block Wall): In Wall

2. Sensor to Panel (Stud Wall): In New Conduit (EMT)

3. Sensor to Panel (Mechanical Room): In New Conduit (EMT)

M. Wiring

1. Type THHN solid #18 AWG for control wiring in dry location up to 194°F.

2. Type THWN in wet location up to 167°F (solid #18 AWG).

3. Twisted shielded pair (18 gauge), with PVC cover, Belden #8760 or approved equal.

4. Conduit is not considered as a shield.

5. All wiring associated with the control signals to the smoke damper control/sequence must be in approved conduit.

6. All signal wiring to all field devices shall be run with no splices, separately from any wiring having voltage greater than 30 volts.

N. The Contractor shall install all shielded cable and ground systems in accordance with Division 23. The installation of ground loops shall not affect any sensing or control circuits.

O. All devices and equipment shall be mounted in minimum NEMA 1 enclosures.

P. In addition to the requirements specified above, all communication wiring cables shall include a minimum of (1) individually 100% shielded pair ([2] conductors) as unused spare conductors. Where the number of conductors and specific cable specified above for each type of communication wiring will not meet this requirement for spare conductors, Contractor shall provide approved equivalent product of Belden or other manufacturer with the necessary number of conductors and which meets the requirements specified above.

Q. Low Voltage Control Wiring

1. All Control components including damper motors, and all other control components shall operate on 24-volt power, unless 120-volt power is provided specifically by the electric trade, and the control components are accepted by the owner for 120-volt power. Any and all items not shown on electrical drawings on 120-volt power shall be provided with 24-volt power components.

2. The contractor shall provide all required step-down transformers as required based upon allowable voltage drops. Obtain power for the control devices from the nearest electrical panel in the Electrical Closet located in the project scope area unless specific panel locations are shown on electric al drawings.

3. Low voltage control wiring shall be minimum 16 gauge, or heavier if required, twisted pair, 100% shielded with PVC cover Belden #9316 or approved equivalent product of other manufacturers run in conduit with no splices, separate from any wiring above 30 volts.

2.02 Coordination of Interfacing/Interlocking

A. The Contractor shall be responsible for coordinating all required interface/interlocking software, software logic, sequencing and wiring necessary to provide a fully automated and fully functional operable system to met or exceed the intent of the Design Engineer’s Sequence of Operation. This would include coordination of miscellaneous points as specified under point list in this specification. Systems to include all points analog, digital, software, wiring, communications gateways, etc., to connect and communicate to existing BMS systems.

2.03 CUSTOM APPLICATION CONTROLLER (CAC)

A. General Requirements

1. Custom BACnet Application Controllers shall be equipped with either a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software (manufacturer’s tool sets as defined in Article 2.1) and application programs shall be stored in programmable, non-volatile memory.

3. The CAC unit shall be equipped with a dedicated clock battery, continuously recharged via trickle-current, or equivalent.

B. CAC Software

1. General: A CAC shall be able to operate in standalone mode, as needed for specified control applications. Software shall include a complete operating system (O.S.), communications handler, point processing,

standard control algorithms, and specific control sequences.

2. O.S. software shall reside in programmable flash memory, operate in real-time, provide prioritized task scheduling, control time programs, monitor and manage CAC to OI communications, and scan inputs and outputs. O.S. shall also contain built in diagnostics.

3. Input/Output Point Processing Software shall include:

   a. Continuous update of input and output values and conditions. All continuous points are to be updated at a minimum of one-second intervals.

   b. Reasonability checks on all analog inputs against the previously read value and discards those values falling outside pre-programmed reasonability limits.

   c. Assignment of proper engineering units and status condition identifiers to all analog and digital input and outputs.

   d. Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input or to assign a set of floating limits (alarm follows a reset schedule or control point) to the input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons shall be made each scan cycle.

   e. De-bounce of digital inputs to prevent nuisance alarms. De-bounce timing shall be adjustable from two seconds to two minutes in one-second increments.

4. Alarm Lockouts

      1) Alarm lockout software shall be provided to prevent nuisance alarms. On initial start-up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Lockout period is to be programmable on a per point basis from 0 to 90 minutes in one-minute increments.

C. Custom DDC Control Loops

1. Custom DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications. Each DDC Controller shall have residential in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences:

1) All DDC setpoints, gains and time constants associated with DDC programs shall be available to the operator for display and modification via the SOC (portable operator's terminal).

2) DDC control programs shall include an assignment of initialization values to all outputs to assure that controlled devices/controllers assume a fail-safe position on initial system start-up.

2.04 ELECTRONIC INPUT/OUTPUT DEVICES

A. Temperature Sensors and Transmitters

1. General Sensor & Transmitter Requirements

a. Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation and as required achieving the specified accuracy as specified herein.

b. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.

c. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearity of the sensor and bridge and provide a true linear output signal.

d. Temperature sensors shall be of the resistance type and shall be either three-wire 100-ohm platinum RTD, or two-wire 1000-ohm platinum RTD.

e. Thermistors may be acceptable provided that the temperature vs. resistance curves are contained either in the controller's software or firmware and that its performance is as specified herein elsewhere. Submit proof of the software mathematical equation or the firmware conversion charts together with the temperature/resistance charts from the manufacturer of the sensor. Thermistors shall be of the Thermistor (NTC) Type with a minimum of 100 ohm/°F resistance change versus temperature to insure good resolution and accuracy. Thermistors shall be certified to be stable ±0.24°F. over five years and ±0.36°F. accurate and free from drift for five years.

f. The following accuracies are required and include errors associated with the sensor, lead wire and A to D conversion.

Point Type	Accuracy
• Room Temperature	1.00°F
• Duct Temperature	0.5°F

2. Sensors used in BTU or process calculations shall be accurate to ±0.10°F. over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Bureau of Standards (NBS) Calibration Report Nos. 209527/222173.

3. Room Sensors (Temperature Only)

a. Terminal unit temperature sensors shall all be of the thermistor (NTC) type with a 100-ohm/oF resistance change versus temperature change to insure good resolution and accuracy.

b. Sensor shall be supplied with a vertical base for mounting on a standard single gang junction box supplied by the Temperature Control Contractor.

c. Sensors shall be able to provide access to a local BACnet network using built-in communication jack.

d. Programmable BACnet thermostats (with ability to connect to BACnet network)

4. In lieu of having a separate remote temperature sensor driving a native BACnet controller, one may combine

the sensor and controller components into one thermostat.

5. BACnet thermostats shall have integral temperature sensor with LCD and setpoint adjustments of +3°F. Projects shall use a central BACnet scheduler.

6. Thermostat shall be powered from 24VAC. Thermostat shall provide BACnet Standard Objects for Space Comfort Controller. Thermostat shall be able to provide peer to peer communication and shall utilize the BAcnet protocol.

B. Electronic Damper Actuators

1. General Requirements (where required)

a. Electronic actuators shall be electric, direct-coupled type capable of being mounted over the shaft of the damper. They shall be UL-listed and the manufacturer shall provide a 2-year unconditional warranty from the date of Substantial Completion. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque or 35 dB for VAV actuators.

b. Electronic overload protection shall protect actuator motor from damage. If damper jams, actuator shall not burnout. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.

c. Electronic damper modulating actuators shall be driven by a 0-10VDc or 4-20 mA signal.

2. Control Damper Actuators

a. Damper actuators shall be modulating, spring-return, normally-closed for fail-safe operation.

b. The control circuit shall be fully modulating using 0-10VDC or 4-20mA signals. Accuracy and repeatability shall be within ±1/21 of control signal. A 0-10VDC or 4-20mA signal shall be

produced by the actuator that is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating damper position. Accuracy shall be within ±2.5%.

c. Acceptable manufacturers: Belimo, Siemens (formerly Staefa), Dodge, TAC or Delta.

1) Power: Nominal 24 VAC, 60 Hz.

2) Operating Temperature: 32°F to 122°F

3) Display Range: -40°F to 122°F

4) Transceiver for MS/TP network: RS-485; 38.4 kbps

5) LCD: 2 rows – 8 characters each

6) Resolution: +/- 0.2°F

7) Control Accuracy: +/- 0.9°F at 70°F (calibrated)

8) Sensor Range: Heating: 40°F to 90°F

9) Sensor Range: Cooling: 54°F to 100°F

10) Provide local programmable occupied/unoccupied override adjustment for PA Spaces.

11) Remote mount temperature sensor: shall be 10 K-ohm NTC thermistors or approved equal

2.05 TEMPERATURE AND ELECTRICAL MEASURING APPARATUS

A. Current Transformers

1. The current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.

2. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.

3. The current transformers shall meet the following specifications:

   a. Frequency Limits: 50 to 400 Hz.

   b. Insulation: 0.6 KV Class, 10 KV BIL.

   c. Accuracy: ±1% at 5.0 to 25.0 VA accuracy class with U.P.F. burden.

4. Provide a disconnect switch for each current transformer.

B. Current Sensing Switches

1. Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip into range.

C. Relays

1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type when mounted within an enclosure. Relay configurations that are also acceptable include assemblies that house relay contacts within their own enclosure which is mounted externally on an enclosure. Number of contacts and operational function shall be as required.

2. Solid State Relays (SSR): Input/output isolation shall be greater than 10E9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz. The contact life shall be 10 x 10 E6 operations or greater. The ambient temperature range of SSRs shall be -20 to +140°F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

D. Contactors:

1. Contactors shall be Definite Purpose specifically designed for the heating, ventilating, air conditioning, and refrigeration industry (HVACR) and

suitable for the switching of single or three phase loads as applicable.

2.06 BACNET NETWORK COMMUNICATION REQUIREMENTS

A. Wired MS/TP network communication shall be via channels consisting of twisted pair with shield conductor or BACnet approved cable.

B. BACnet IP Cable shall be in accordance with the most recent IEEE 802.3 standards.

C. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.

D. There shall be no power wiring, in excess of 24 VAC, run in conduit with communications wiring. In cases where signal wiring or control power wiring is run in conduit with communication wiring, all communication wiring, signal wiring and control power wiring shall be run using separate twisted shielded pairs with the shields grounded in accordance with the manufacturer’s wiring practices. Low voltage power wiring that exceeds 24 VAC shall be run separate from the BACnet communications twisted pair (MS/TP) and/or BACNet IP BACnet wiring.

E. System Architecture

1. The Contractor shall provide the BACnet control BACnet network as shown on the contract drawings.

2.07 ALARMING, TRENDING, AND SCHEDULING NETWORKING FUNCTIONS

A. The Contractor shall coordinate with the BMS vendor for the following control network communication functions:

1. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state.

a. Binary Alarms: Each binary object shall be set to alarm based on the operator specified state.

b. Analog Alarms: Analog alarms shall be provided by the CONTRACTOR and each analog object shall have both high and low alarm limits and warning limits. Alarming shall be able to be automatically and manually disabled.

2. The BMS vendor software is to be utilized to display alarming, event logging or trending where this software is employed as the GUI. All binary alarming, capacity calculations, etc., are to be accomplished at the local CAC.

B. Applications Editors. Each DDC Controller shall support full screen editing of all system applications. Contractor shall provide editors for each application at DDC Controller(s). The applications shall be downloaded and executed at the appropriate DDC Controller(s). All controlling, scheduling, start/stop applications are to be compatible with the BMS software and as approved by the Engineer.

1. Controller. Contractor shall provide a full screen editor for each type controller and application that shall allow the operator with proper password to view and change the configuration, name, control parameters, and system setpoints.

2. Scheduling. Contractor shall provide an individual 7-day time schedule for each piece of equipment controlled by the BMS. Each of these schedules shall include the capability for start, stop, and night economizer actions. Each schedule may consist of up to (10) events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

   a. Weekly Schedule. Provide separate schedules for each day of the week.

   b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it shall be discarded and replaced by the standard scheduled for that day of the week.

   c. Holiday Schedules. Provide the capability for the operator to define special or holiday schedules. These schedules may be placed on the scheduling calendar and shall be repeated each year. The operator shall be able to define the length of each holiday period.

d. Equipment Coordination. CONTRACTOR shall provide a full screen editor that allows equipment to be grouped for proper operation as specified in the sequence of operations.

PART 3 - EXECUTION

3.01 PROJECT MANAGEMENT

A. The Contractor shall designate a project manager who will be responsible for the following:

1. Construct and maintain project schedule.

2. On-site coordination with all applicable trades and subcontractors.

3. Authorized to accept and execute orders or instructions from Owner/Architect.

4. Attend project meetings as necessary to avoid conflicts and delays.

5. Make necessary field decisions relating to this scope of work.

6. Coordination/Single point of contact.

3.02 NUMBERING/NAMING CONVENTIONS

A. The Contractor shall collaborate with the Owner directly to determine the Owner’s preference for naming conventions, etc. before entering the data in the system.

B. As a minimum the Contractor shall submit to the Architect/Engineer and Owner the layout of the network, identifying all DDC controllers. Each controller will be identified by address and system being served. All physical and software generated objects, points and attributes shall be listed along with a description.

3.03 START-UP AND COMMISSIONING

A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

B. Provide any recommendation for system modification in writing to Owner. Do not make any system modification, including operating parameters and control settings, without prior approval of Owner.

C. The Contractor will provide industry standard checkout and startup checklists for each DDC controller installed for the project. If not standard is available, the Contractor shall develop a spreadsheet in MS Excel format and submit to the Engineer for approval prior to system checkout.

3.04 INSTRUCTION AND ADJUSTMENT

A. The Contractor shall provide factory-trained instructor to give full instructions to the owner designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 AM to 5:00 PM weekdays.

B. Upon completion of the project, the Contractor shall:

1. Fine-tune and “de-bug” all software control loops, routines, programs and sequences of control associated with the control system supplied.

2. Completely adjust and make ready for use, all transmitters, relays, damper operators, etc., provided under this Section. The Contractor shall furnish copies of complete, detailed, calibrating checkout and commissioning documentation for reach controller. Documentation shall list each procedure and shall be signed by the control specialist performing the service.

3. Furnish a complete set of system operation manual, including standard manufacturers’ operating manuals, complete as-built installation diagrams, and complete software hardcopy documentation, as well as a magnetic media back-up.

4. Provide an on-site training program for the Owner’s staff in the operation and use of the control system. Training shall include three (2) segments, as follows:

a. Segment 1 shall include 16 hours of classroom and hands-on training. This segment shall instruct personnel in the system configuration, component

characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment shall give the Owner’s representative a working proficiency in the day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).

b. Segment 2 shall include 6 hours of on-site training. This segment will be geared for the Owner’s designated prime operator. An emphasis on overall software management and manipulation shall be made, to allow the prime operator(s) to make control strategy and overall facility and system management changes as required. Attendees shall have attended Segment 1.

c. All training shall take place at the site and at times mutually agreed to between that Contractor and the Owner. The Contractor shall provide to the Owner’s designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule.

END OF SECTION 230900

SECTION 232000 – HVAC PIPING AND JOINTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

A. Furnish and install all piping, fittings, flanges, unions, bolting, gaskets, welding, and threading for all main piping network, branches and connections to all HVAC and systems to make complete and operations systems.

B. All systems shall be installed in accordance with local code including vent piping and relief discharge termination points.

C. Secure all permits and local/state approvals for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. ASME: American Society of Mechanical Engineers

C. NFPA: National Fire Protection Association

1. NFPA 54: National Fuel Gas Code

D. ANSI: American National Standards Institute

1. A13.1: Scheme for Identification of Piping Systems

2. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings

3. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

4. B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 800, 1500 and 2500

E. ASTM: American Society for Testing and Materials

1. B 75: Seamless Copper Tube

2. B 88: Seamless Copper Water Tube

3. F 36: Compressibility and Recovery of Gasket Materials

4. F 37: Sealability of Gasket Material

5. F 38: Creep Relaxation of a Gasket Material

6. F 146: Fluid Resistance of Gasket Materials

7. F 104: Non-metallic Gasket Materials

8. F 152: Tension Testing of Nonmetallic Gasket Materials

F. Copper Development Association

1.05 SUBMITTALS

A. See Section 232000 and General Conditions for additional information.

B. Product Data: Include date on pipe materials, pipe fittings and accessories. Provide manufacturers catalogue information and mill certificates.

C. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual locations of all piping, valves, traps and valve tag numbers.

E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

F. Provide piping plans to a minimum scale of ¼" - 1'-0".

1.06 QUALITY ASSURANCE

A. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

A. Protect piping systems and specialties from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 ENVIRONMENTAL

A. Do not install piping when environmental conditions are outside the specific limitations of the referenced codes and manufacturer’s recommendations.

PART 2 – PRODUCTS

2.01 GENERAL

A. Provide all piping, fittings, flanges, couplings, unions, bolting, gaskets, welding, threading and soldering for main piping network, branches and connections to equipment as shown on the drawings and as required to provide complete systems. All piping, fittings and accessories shall conform to the appropriate Service Pipe Schedule as specified hereinafter.

1. Acceptable manufacturers contingent on compliance with the specifications.

a. Pipe

a) Cambridge Lee
b) Cerro

B. General

1. All pipe and fitting shall be new, first quality material suitable for continuous operation under the conditions specified. All material shall be in conformance with ANSI Standards.

2. All pipe shall be a product of the United States of America. Mill certificate shall be provided as required.

3. All piping shall be clearly marked with material specification.

4. All pipe and material shall comply with the requirements and recommended practices of ASME B31.1 Power Piping Code (latest Edition and Addenda).

5. Elbows shall be long radius ANSI B16.9 unless otherwise specified.

6. Fittings shall be used at all branch connections from headers.

7. Acceptable fittings shall be tees. "Weldolets", "Threadolets" and "Sockolets" will also be allowed as specified. Fishmouth or shaped nipples will not be allowed.

8. All pipe and fittings with threaded ends shall have IPS threads cut clean and true and in conformance with the ANSI B1.20.1.

9. Threaded pipe and fittings shall be made up with special care to avoid marring or damaging pipe and fitting surfaces.

10. All threaded joints in copper pipe shall be made up with Teflon pipe tape, petroleum gas grade, wound on male threads, clockwise as viewed from end of pipe.

11. No joints shall be "backed-off" to align pipe and fittings.

12. Gauge lines shall be stainless steel with compression fittings.

2.02 SERVICE PIPE SCHEDULE

Service	**Type**	**Grade**	**Wall**		**Joints (Minimum Sch. Shall match Wall)**	
					2" and Less	**2½" & Up**
Miscellaneous drains to 2"	Hard Drawn Copper	ASTM B306	Type DWV		DWV 95-5 Solder	
Refrigerant system	Hard Drawn Copper ACR	ASTM B280	Type ACR		Silver Brazed	Silver Brazed

2.03 FITTINGS

A. For Copper Tubing

1. Solder Joint: Wrought Copper, ANSI B16.22 or Cast Bronze B16.18.

a. 2" and less

1) Silver brazing alloy.

b. 2½" and larger

1) Silver brazing alloy.

a) For refrigerant piping and where noted: Silver brazing alloy, similar to Handy and Harman Easy-Flo.

PART 3 – INSTALLATION

3.01 PIPING INSTALLATION

A. Provide all piping systems as shown on the drawings and otherwise required to make a complete, workable and neat job, installing all valves, appurtenances, and unions. The Contractor shall use care arranging all piping as shown on the drawings and shall carefully examine the arrangements where offsets are indicated and shall follow details as shown.

B. All piping shall be run to true alignment generally parallel or perpendicular to adjacent building walls, floors and ceilings and with uniform grades and spacing so as to present a neat and workmanlike appearance.

C. Care shall be paid to the exact locations for all piping and equipment with respect to equipment, ducts, conduits, slabs, beams and lighting fixtures, so as to provide maximum access to all mechanical and electrical equipment in the buildings. Close coordination and cooperation shall be exercised with other Trades in locating the piping and equipment in the best interests of the Owner. The drawings and specifications covering other work to be done in the buildings shall be carefully studied and arrangements made to avoid conflict.

D. The drawings shall be followed where they are definite and provided such procedure causes no objectionable conditions or does not conflict with other Trades, Laws, Regulations or recommendations of equipment manufacturers. The drawings are intended to indicate the sizes of piping connections and if certain sizes are omitted, or unclear, obtain additional information before proceeding.

E. Rough in for all equipment requiring connections to the Mechanical work. Obtain all necessary data on exact locations, sizes, connections, fittings and arrangements and exact routings as may be required for proper installation.

F. Unions, shall be provided in conjunction with all equipment, coils, control valves and specialties in all pipe lines and at all points necessary to provide reasonable access to the piping systems.

G. Ends of all pipes shall be reamed clean and all pipes shall be straightened before erection and measures shall be taken to preserve this cleanliness after erection.

H. Support piping independently at all equipment so that the equipment is not stressed by piping weight or expansion.

I. Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation.

J. Provide dielectric unions, waterway fittings or flanges between dissimilar pipe materials to prevent galvanic action as required.

K. Provide proper provision for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected. Provide double swings at riser transfers and other offsets to take up expansion. Arrange riser branches to take up motion of riser. Branch runouts to equipment shall have a minimum of (3) elbows, adequately spaced.

L. All piping connections to equipment shall be made with offsets. Provide with unions, arranged that the equipment can be serviced or removed without dismantling the piping. If equipment, when commissioned, becomes air bound or stratified, all necessary modifications to the piping system required to rectify the condition permanently shall be made to piping and equipment, furring, floors, walls, etc., at the Contractor's expense.

M. Pipe pitch, unless otherwise indicated on the drawings, shall be as follows:

1. Condensation Drainage:

a. Preferred: 1/4 in./ft., down in direction of flow.

b. Minimum: 1/8 in./ft., down in direction of flow.

N. Copper tubing and galvanized steel shall not be mixed in any one run of piping, except as otherwise specified herein.

O. During construction, temporarily close open ends of pipes with sheet metal caps or duct tape to prevent debris from entering piping systems.

P. Where condensate piping, to meet job conditions, may have to set down under stoops, doors, etc., and again rise after passing these, the sets shall be made with 45° fittings and with Y-laterals at each end, with brass plugs to permit easy cleaning of trapped portions of pipe. At any points where return mains have to rise again, after being depressed, provide overhead "air lines" (not smaller than 1" in size) and connect the (2) high sides. Any turns in water sealed lines shall be made with crosses, with brass plugs in unused outlets to facilitate cleaning.

Q. Joints in piping systems, for all services, shall be made tight and leakproof against test pressures. Leaks in screwed or flanged joints which cannot be eliminated by normal wrench tightening methods shall be repaired at the joint. Under no circumstances shall caulking be allowed. No joints shall be backed off to align pipe fittings.

R. Refrigerant Piping and Connections

1. Provide all refrigeration piping, including thermal expansion valves, driers, moisture indicator sight glasses, shutoff valves, controls, gauges, insulation and other appurtenances, as required to complete the refrigeration system. Piping connections to the units shall be fitted with flexible pipe fittings and renewable unions.

2. The Contractor shall triple evacuate and field charge entire refrigeration system. All labor and materials required for evacuation, charging, as well as commissioning of the refrigerant systems, shall be provided by the Contractor. The refrigerant piping arrangement shall be in strict accordance with manufacturer's recommendations. Provide shop drawings indicating sizes and all required components and accessories for Architect's review prior to ordering equipment or installation.

3. All refrigerant piping exposed to weather outside the building shall be properly supported in a manner to allow expansion and contraction. All sleepers provided shall be secured and their installation shall be as directed and approved by the Architect.

4. Refrigerant piping joints shall be made with cadmium free 45% silver brazing filler metal having a melting point of 1225°F. Joint flux, if used, shall be compatible with materials. The outside surface at end of pipe and inside surface of fittings shall be thoroughly cleaned with steel wool or emery cloth, and cut pipe ends shall be reamed and all burrs shall be removed. Care shall be taken to ensure the entry of foreign particles into the system does not occur. While brazing, purge piping with low pressure nitrogen to prevent interior oxidation and to dry the system. Caution must be taken to continuously ventilate the work area and to avoid allowing nitrogen to concentrate in an enclosed area thereby expelling all of the oxygen and causing asphyxiation.

5. Traps shall be factory fabricated one-piece fittings or field assembled 45°-90°-45° elbows. Do not use 90°-90°-90° elbows.

3.02 CLEANING AND BLOWING OUT

A. The equipment and piping installed under this Section shall be blown out under pressure and cleaned of foreign matter, through temporary connections where necessary, before the system is placed in service. Precautions shall be used to prevent foreign matter from getting into equipment and piping during construction. The supplier of water treatment equipment and chemicals shall recommend and furnish chemicals for the purpose of cleaning and blowing out of all systems. All chemicals, materials, instruments and labor shall be provided by the Contractor.

B. The surfaces of all equipment and piping shall be clean upon completion of the work.

C. All pipe line strainers shall be cleaned immediately before being turned over to the Owner for acceptance.

D. During cleaning process, hammer welds to remove scale, weld slag and other debris.

3.03 TESTING

A. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of the tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Perform all tests other than herein specified which may be required by Legal Authorities or by Agencies to whose requirements this work is to conform.

C. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to the Owner.

D. All equipment and piping installed under this Contract shall be tested and found tight. Insulated or otherwise concealed piping shall be tested before being closed in. All leaking joints shall be corrected, retested and found tight. Such tests shall conform to the requirements of Local Codes but shall not be less than the equivalent of the tests called for herein. Threaded joints that leak shall not be seal-welded to correct leakage.

E. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.

F. All piping systems shall be subjected to a hydrostatic test at 1 1/2 times operating pressure measured at the highest point in the system, for a period of (4) hours without drop in pressure.

G. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.

H. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

I. Welded joints shall be subjected to a hammer test while under pressure.

END OF SECTION 232000

SECTION 233900 – FANS AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

A. Furnish and install all fans of the various types, arrangement and sizes specified herein and as scheduled on the drawings.

B. Fans shall include all motors, drives, special coatings and accessories.

C. Furnish and install all automatic dampers.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. AMCA 99 – Standards Handbook; 1986.

2. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes; 1985.

3. AMCA 261 – Directory of Products Licensed to Bear the AMCA Certified Ratings Seal; 1995.

4. AMCA 300 – Test Code for Sound Rating Air Moving Devices; 1994.

5. AMCA 301 – Method of Publishing Sound Rating Air Moving Devices; 1994.

6. NEMA MG 1 – Motors and Generators; 1993 (and Revision 1).

7. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial Cooking Equipment; 1994.

8. UL 705 – Power Ventilators; 1994.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Submit certified curves showing fan performance with system operating points plotted on curves.

C. Submit motor data sheets including motor efficiency and power factor at various loadings of nameplate horsepower. Motor efficiency and power factor shall be shown for 100%, 75% and 50% of nameplate horsepower. Submit data on efficiency and power factor required for motors 1 HP and above only. Motors shall have premium efficiency motors with minimum efficiency on motors listed in specification.

D. Submit bearing sizing calculations for each similar size and type of fan. Fan bearing calculations shall be based on fan at maximum operating conditions including belt pull. Calculations shall be done for both fan bearings and motor bearings. Calculations required on centrifugal fans, vent sets in-line fans, wall mounted propeller fans and vane axial fans only.

E. Submit sound power levels for each size and type of fan. Sound levels shall be in all (8) octave bands for discharge of fan, inlet to fan, and radiated noise through casing.

F. Submit certified shop drawings indicating all dimensional data, and operating and maintenance clearances.

1.06 QUALITY ASSURANCE

A. Fans shall conform to most recent AMCA Bulletins regarding construction and testing. Fans shall be tested and rated per AMCA and shall be selected in proper operating range without motor overloading and fan surge.

B. Manufacturers must prove experience in the production of similar products of this type for at least ten (10) years prior.

C. Fans shall be air and sound certified in accordance with AMCA 210 and 300 and shall bear the AMCA seal.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and other testing firm acceptable to the authority having jurisdiction and all suitable for the purpose specified and indicated.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated and fan has been test run under observation.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturers acceptable contingent upon product's compliance with the specifications are as follows:

1. Inline Fans

a. Greenheck Fan Corp.

b. Loren Cook Co.

c. ACME Fan Co.

d. Twin City Fan

B. Selection and Balancing

1. Provide and install items as listed in equipment schedules, as shown on drawings, and as specified, complete in all respects to the functions intended.

2. Provide fans capable of accommodating static pressure variations of ±10%.

3. Provide balanced variable sheaves for motors 15 HP and under, and fixed sheaves for 20 HP and over.

4. Statically and dynamically balance fans in the field to eliminate vibration or noise transmission to

occupied areas of the building. Provide certificate of compliance from manufacturer.

5. Provide OSHA and ANSI approved belt guards on interior mounted belt driven fans. Provide weatherproof ventilated housing for exterior mounted fans.

6. Provide safety, bird or insect screen where inlet or outlet is exposed.

7. All fans shall be manufactured in accordance with this specification even where techniques are required which are not considered standard by that manufacturer.

8. Verify fan arrangement with the Contractor including motor location for servicing and discharge arrangements for proper airflow.

9. Where fixed speed sheaves are specified for a particular fan, provide (2) additional sheaves (one motor and one drive) as necessary for final air balancing.

C. Painting

1. Each fan component shall be thoroughly cleaned, degreased and deburred before the application of a rust preventive primer.

2. Two (2) coats of a rust preventive primer shall be applied under a topcoat of air-dried epoxy or enamel. Minimum coating thickness shall be 5 to 6 mils. The final coat shall be applied after final assembly to all surfaces.

2.02 FAN DRIVES

A. All single phase fans shall be provided with speed controllers with all required wring modifications.

2.03 CEILING EXHAUST FAN

A. Ceiling-mounted exhaust fans shall be of the centrifugal direct drive type. The fan housing shall be constructed of heavy-gauge galvanized steel. The housing interior shall be lined with 0.5 inch acoustical insulation. The outlet duct collar shall include a plastic backdraft damper. Outlet shall be adaptable for horizontal or vertical discharge. The grille shall be constructed of non-yellowing high-impact polystyrene and attached to the housing with hidden attachment screws.

B. The access for wiring shall be external. The motor disconnect shall be internal and of the plug-in type.

C. The motor shall be mounted on vibration isolators. The fan wheel shall be of the forward-curved centrifugal type and dynamically balanced. The fan shall have a rocker switch with 3 cfm settings located internally.

D. Upon installation, the switch shall be selected to the desired CFM.

E. All fans shall bear the AMCA Certified Ratings program AMCA Sound and Air Performance seal and shall be UL/cUL Listed.

2.04 INLINE CABINET FANS

A. Duct-mounted exhaust, supply or return air fans shall be of the centrifugal direct drive type. The fan housing shall be constructed of heavy-gauge galvanized steel.

B. The housing interior shall be lined with 0.5 inch (13 mm) acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge. The access for wiring shall be external. The motor disconnect shall be internal and of the plug-in type.

C. The motor shall be mounted on vibration isolators.

D. The fan wheel shall be of the forward-curved centrifugal type and dynamically balanced.

E. All fans shall bear the AMCA Certified Ratings program AMCA Air Performance Seal and shall be UL/cUL Listed.

PART 3 - FAN INSTALLATION REQUIREMENTS

3.01 INSTALLATION

A. Fans shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Fans shall be installed so as to ensure easy accessibility for service or removal or replacement of all components such as, but not limited to, fans, motors, belts, drives, bearings, dampers, actuators, isolators, and field connections.

C. The Contractor shall install all motors and drives shipped loose. Fans shall be installed and tested, and shall be made fully operational by the Contractor.

D. Provide fixed sheaves as necessary for final air balancing. The Contractor shall install the fixed sheave after balancing with the Contractor to adjust the fans.

E. Manufacturer shall include the adjustment of pitch for adjustable pitch fans as required by balancing.

F. All fans shall have flexible inlet and outlet couplings to prevent vibration transmission to ductwork.

G. The Contractor shall assemble all loose parts including motors and drive assemblies on site and shall vibration balance the fans in the field. Field adjustment including belt alignment, wheel balancing, belt tension, greasing of bearings, installation of belt guards, and other loose parts shall be provided by the Contractor.

3.02 COORDINATION

A. The Contractor shall coordinate the fan arrangement with the coordinated ductwork layout prior to ordering the fan. The Contractor shall provide all labor and materials necessary to change fan arrangement in the field when fan arrangement does not match ductwork.

B. The inlet and/or discharge ductwork shall have a minimum straight run of (2) fan diameters upstream and downstream of the fan. The Contractor shall notify the Engineer in writing if these conditions cannot be achieved. Installation of improper inlet/discharge conditions without the review of the Engineer shall be corrected in the field at no cost to the Owner.

C. The Contractor shall provide all supplemental steel, supports, rods and hangers necessary to hang or mount fans. Supports shall include thrust restraint as required by the fan manufacturer.

D. The fan manufacturer and Contractor shall coordinate the fan orientation for tubular centrifugal fans and shall verify that the fan support and bearings are supplied for the coordinated fan orientation (horizontal or vertical). The Contractor shall revise the fan in the field if job conditions require changing of orientation, at no cost to the Owner.

E. The Contractor shall receive and inspect all fans and motors to make sure that all fans are received without defect. All defective or damaged fans shall be returned to the manufacturer by the Contractor for replacement.

F. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition. Fans used for temporary ventilation during construction shall be totally cleaned and refurbished prior to turnover to the Owner.

G. The Contractor shall mount and vibration balance all fans. The Contractor shall furnish and install power wiring to the fan motor and verify proper fan rotation. The Contractors shall coordinate the starter requirements to ensure that the proper starter is installed for non-standard motors. The Contractor shall wire all interlocking wiring to the fan including smoke detector wiring for fan shutdown.

H. The Contractor shall mount all automatic control dampers on the fan.

I. The Contractor shall mount all field mounted flow measuring devices on the inlet or discharge of the fan prior to fan installation.

END OF SECTION 233900

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.03 SUBMITTALS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated.

B. 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.

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

1.05 COORDINATION

A. Coordinate size and location of base supports for roof mounted units and wall brackets for wall mounted units.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

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

1. Mitsubishi Heavy Industries America, Inc.; Air-Conditioning & Refrigeration Division, Inc.

2. Sanyo Fisher (U.S.A.) Corp.

3. LG Corporation

4. Daikin Corporation

5. Trane Company (The); Unitary Products Group.

6. York International Corp.

2.02 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Direct drive, centrifugal fan.

D. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency

E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.03 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Inverter-driven twin rotary.

2. Refrigerant Charge: R-410A

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Fan: Aluminum-propeller type, directly connected to motor.

E. Motor: Permanently lubricated, with integral thermal-overload protection.

F. Low Ambient Kit: Permits operation down to -15 deg F (-26 deg C).

G. Mounting Base: Polyethylene.

2.04 ACCESSORIES

A. Control equipment are specified in section 230900.

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan, with the following features:

1. Compressor time delay.

2. 24-hour time control of system stop and start.

3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

4. Fan-speed selection, including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant piping: See section 232000

E. Condensate Pump: The evaporator drain pan shall be provided with the AC Unit manufacturer supplied integral condensate pump where required as per contract drawing equipment schedules Condensate pumps shall be internally wired to the evaporator control for single point electrical power to the evaporator unit as well as for controls such that the evaporator unit shall shut down in the event the condensate pump fails and shall trigger an alarm at the BMS system.

F. Auxiliary Drain Pan Under the Evaporator Unit of 10 Gage Aluminum with UL 508 listed Leak Sensor meeting Mechanical Code of NYS 307.2.3 requirements for operation and control.

G. Control Interface: Provide BACNET Compatible interface for building BMS integration. Unit controls shall be fully compatible with the Building Controls Manufacturer for seamless integration. The AC equipment manufacturer shall coordinate with the Contractor to integrate the factory controls with the Building Management System (BMS).

PART 3 - FAN INSTALLATION REQUIREMENTS

3.01 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard wall-mounting devices securely fastened to building structure.

C. Install roof-mounting compressor-condenser components on equipment support specified in Division 07 Section "roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. BMS shall enable/disable, adjust setpoint, and monitor alarms, space temp and status.

E. Install seismic restraints. (Haggerty Administration Building only)

F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch (25mm). Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

G. Install and connect precharged refrigerant tubing to component’s quick-connect fittings. Install tubing to allow access to unit.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.03 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. 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 proper motor rotation and unit operation.

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

C. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

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

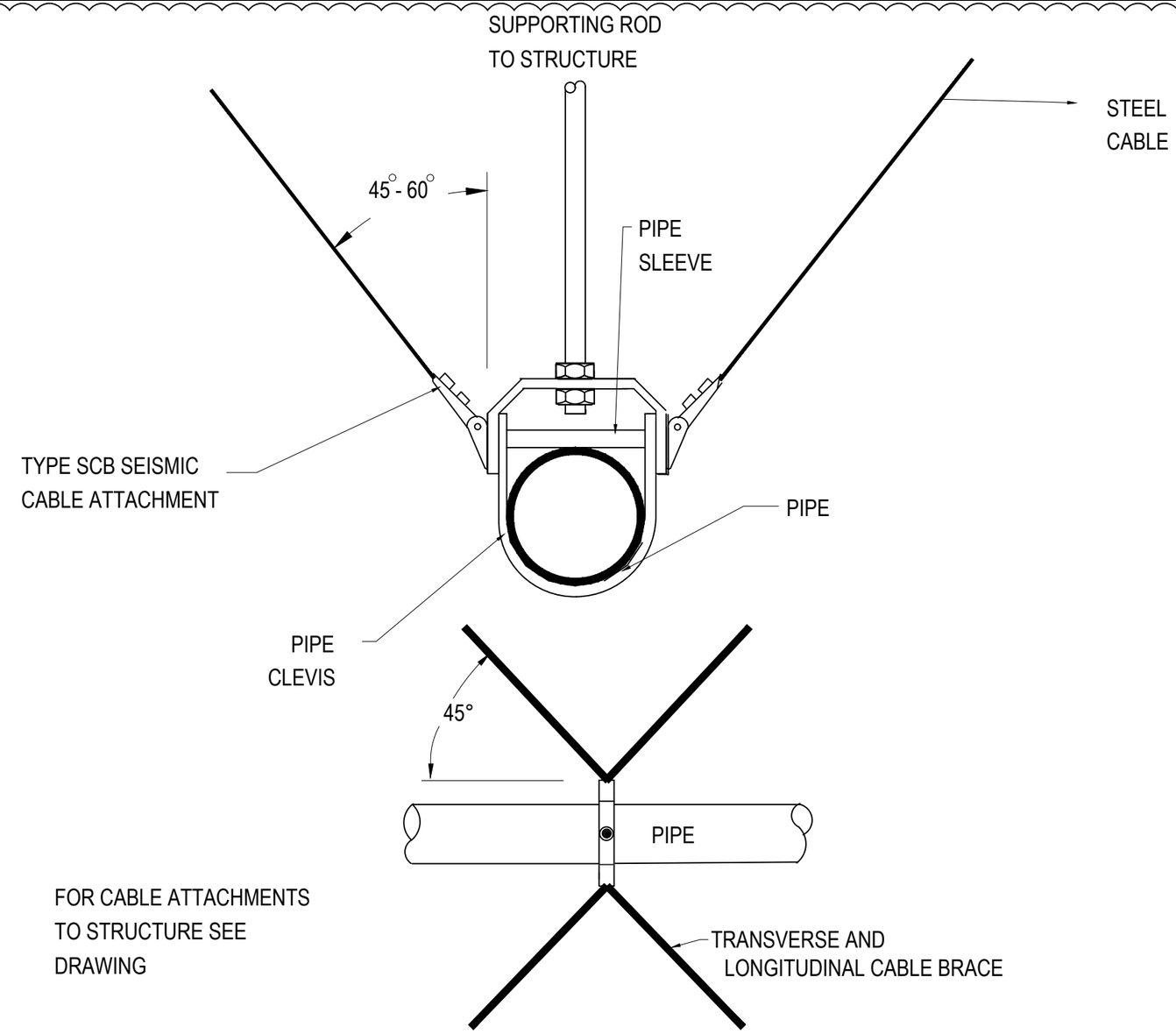
1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

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

B. The manufacturer shall coordinate with the contractor to integrate the factory controls with the BMS. BMS shall enable/disable, adjust setpoint, and monitor alarms, space temp and status.

END OF SECTION 23 81 26



NOTE: SEISMIC FLOOR SUPPORT APPLIES FOR HAGGERTY ADMINISTRATION BUILDING ONLY.

6 SEISMIC DETAIL FOR TRAVERSE AND LONGITUDINAL CABLE BRACE FOR CLEVIS HUNG PIPING

SCALE: NONE

6 / P501 PLUMBING DETAILS

SCALE: 1/8" = 1'-0"

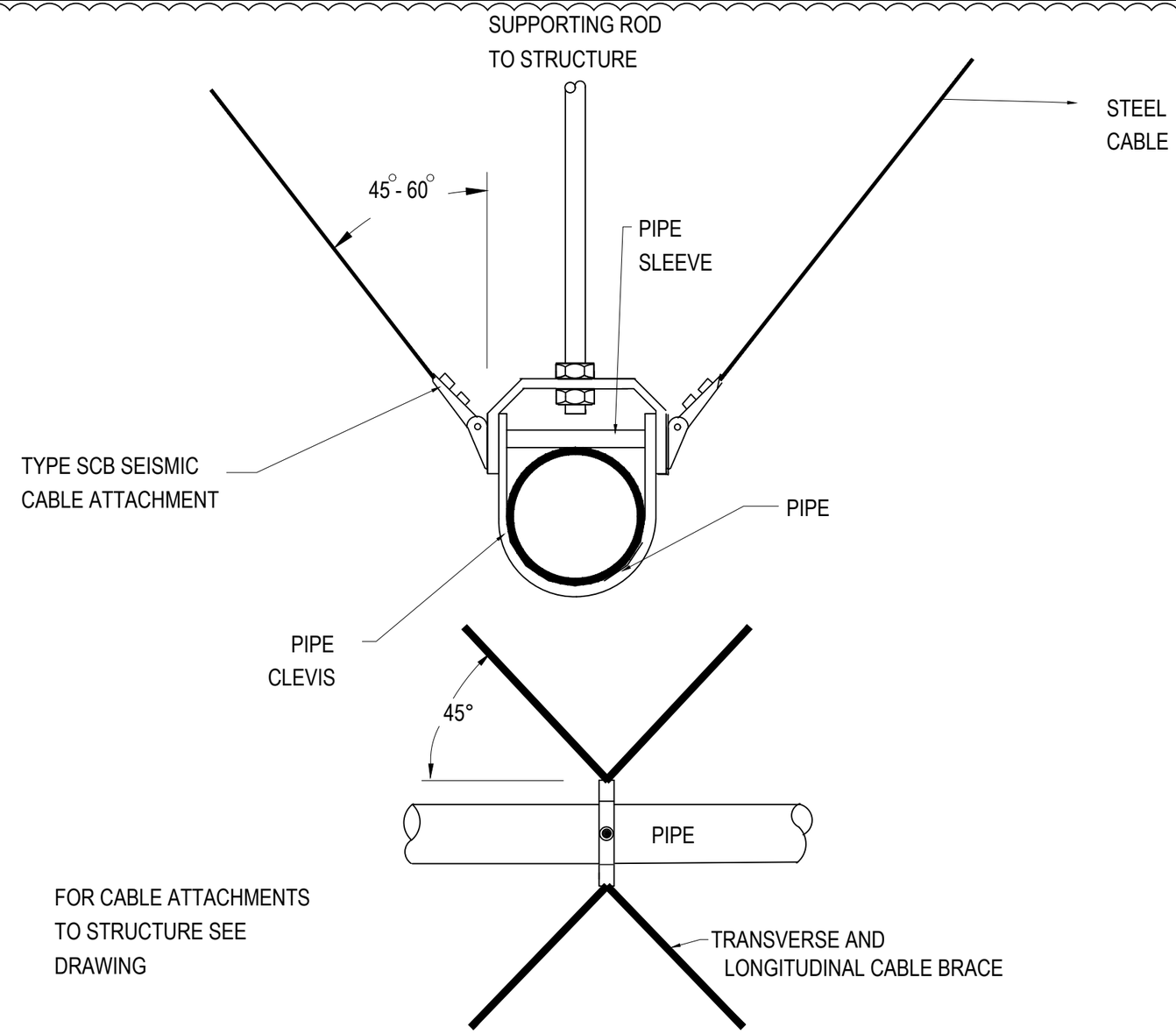
		Input/Output (Note 1)													Software/Firmware Features (Note 2, 3)												Notes
EXHAUST FAN EXHAUST SYSTEM		Sensed				Calculated						Control				Alarms and Advisories (with Instructions)								Misc. Features				
Reference No.	Point Name	Analog Input	Analog Output	Digital Input	Digital Output	Rate of Variable	Totalize Variable	Totalized Runtime	Differential CFM	Differential CO2	Other Calculated	Analog Control	Digital Control	Scheduled Control	Event Control	Supervisory Alarm	Change-of-State	COS OFF-to-ON	COS ON-to-OFF	High Limit Alarm	Low Limit Alarm	Runtime Limit (Hrs)	Other Alarm	Manual Override	"Direct Lon Communication"	Trended Value	Misc. Other	Notes
1	Exh. Fan Status - Hi / Lo Speeds			X																								
2	Exh. Fan Enable/Disable				X																							
3	Exh. Fan Alarm - Fan Failure			X													X									X		

NOTE:

1. THE POINT LISTED HEREIN ARE THE MINIMUM POINTS REQUIRED FOR THE CONTROL AND MONITORING OF THIS EQUIPMENT. THIS POINT LIST IS TYPICAL FOR EACH MECHANICAL/ELECTRICAL SYSTEM OF THIS TYPE. IF THE SEQUENCE OF OPERATION REQUIRES ADDITIONAL OR DIFFERING INFORMATION IT MUST BE PROVIDED BY THE RESPECTIVE PROVIDER OF THE CONTROLS FOR THIS TYPE OF EQUIPMENT AS COORDINATED BY THE GENERAL AND MECHANICAL CONTRACTORS.
2. THE TCC SHALL PROVIDE ALL DIGITAL ALARM LOGIC.
3. PROVIDE BACNET COMPATIBLE CONTROLS AND COORDINATE CONNECTIONS WITH CAMPUS SYSTEM.
4. EF-E-2 & EF-E-3 TO RUN CONTINUOUSLY.

1 / M402 HVAC COYKENDALL SCIENCE BUILDING

SCALE: 1/4" = 1'-0"



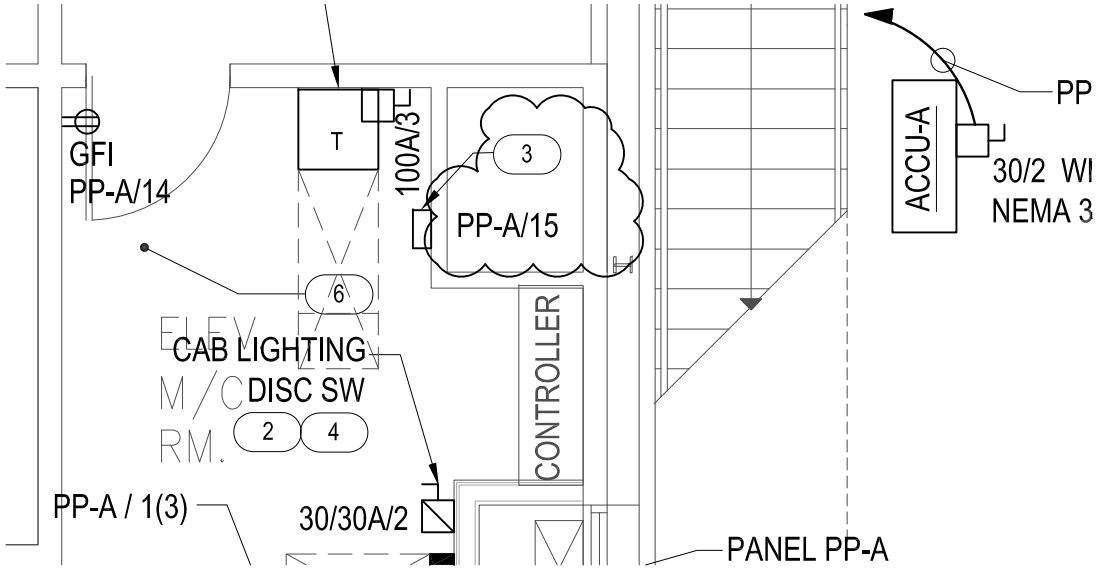
NOTE: SEISMIC FLOOR SUPPORT APPLIES FOR HAGGERTY ADMINISTRATION BUILDING ONLY.

6 SEISMIC DETAIL FOR TRAVERSE AND LONGITUDINAL CABLE BRACE FOR CLEVIS HUNG PIPING

SCALE: NONE

KEY NOTES

3 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



2 CSB PENTHOUSE POWER PART PLAN

SCALE: 1/4"=1'-0"

COYKENDAL SCIENCE BUILDING
CSB-SKE101.00_2

PANEL:	PP-A	MAIN RATING:	OPTIONS:	
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 150A/3P	[X] BONDED GROUND BUS	[ ] DOOR-IN-DOOR TRIM
MAIN BUS RATING:	225A	[ ] MLO:	[ ] ISOLATED GROUND BUS	
AIC RATING:	10k		[ ] 200% NEUTRAL BUS	[ ] INTEGRAL TVSS DEVICE
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS	[ ] INTEGRAL RC SWITCH
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS	[ ] INTEGRAL METERING DEVICE
MOUNTING:	SURFACE			
LOCATION:	ELEVATOR MACHINE ROOM CSB			

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-A	2	100	15	1	2	2	100	30	ACCU-A	2 # 10+ 1 # 10G - 3/4"C
					3	4					
-	SPARE	1	100	20	5	6	1	100	20	SPARE	-
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7	8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9	10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
	SPARE	2	100	30	11	12	1	100	20	SPARE	-
					13	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	15	16	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
-	SPARE	1	100	20	17	18					
	SPARE	1	100	20	19	20					
	SPARE	1	100	20	21	22	1	100	20	SPARE	-
	SPARE	1	100	20	23	24	1	100	20	SPARE	
	SPARE	1	100	20	25	26	1	100	20	SPARE	
	SPARE	1	100	20	27	28	1	100	20	SPARE	
	SPARE	1	100	20	29	30	1	100	20	SPARE	
	SPARE	1	100	20	31	32	1	100	20	SPARE	
	SPARE	1	100	20	33	34	1	100	20	SPARE	
	SPARE	1	100	20	35	36	1	100	20	SPARE	
REFER ONLINE DIAGRAM	ELEV # 1 (15HP)	3	100	70	37	38	3	100	20	SPARE	
					39	40					
					41	42					

N — PHASE A B C — G

* ELEVATOR CB WITH SHUNT TRIP
** GFIC CIRCUIT BREAKER

1 COYKENDAL SCIENCE BUILDING PANEL SCHEDULE - PP-A

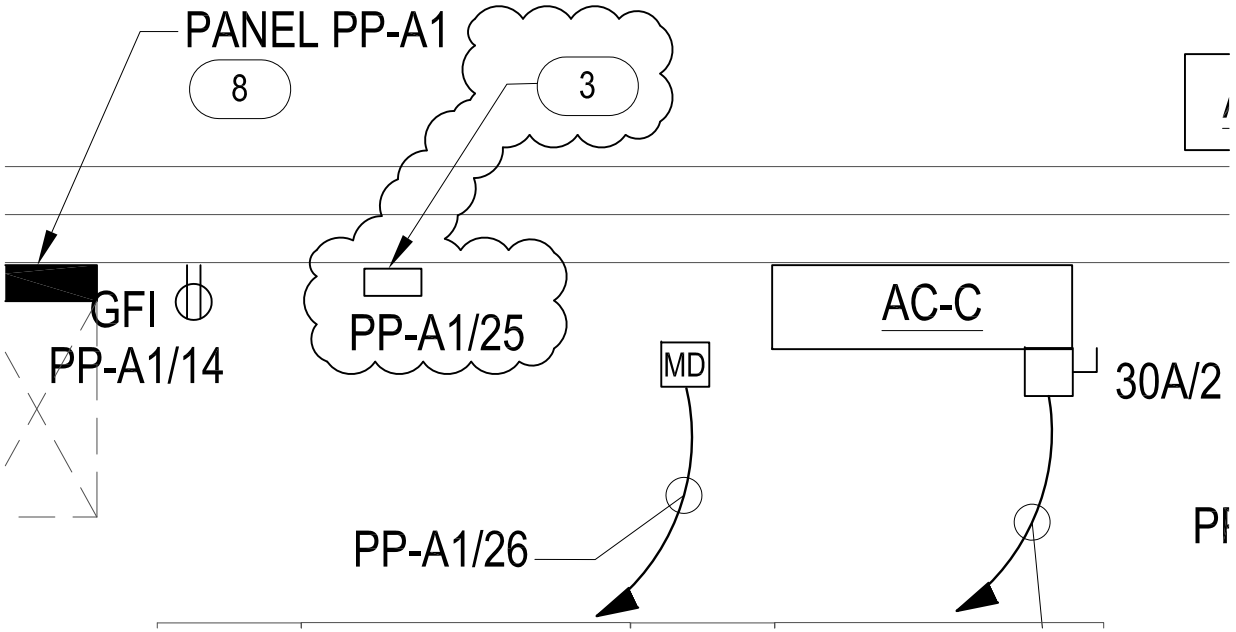
SCALE: NTS

COYKENDAL SCIENCE BUILDING
CSB-SKE601.00_2

ATTACHMENT 14, ADDENDUM 6, 12/07/2022

KEY NOTES

3 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



2 HAB PENTHOUSE POWER PART PLAN

SCALE: 3/8"=1'-0"

HAGGERTY ADMINISTRATION BUILDING
SAB-SKE101.00_2

PANEL:	PP-A1	MAIN RATING:		OPTIONS:
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS	[ ] DOOR-IN-DOOR TRIM
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS	
AIC RATING:	10k		[ ] 200% NEUTRAL BUS	[ ] INTEGRAL TVSS DEVICE
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS	[ ] INTEGRAL RC SWITCH
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS	[ ] INTEGRAL METERING DEVICE
MOUNTING:	SURFACE			
LOCATION:	ELEVATOR MACHINE ROOM HAB			

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-C	2	100	15	1	2	2	100	30	ACCU-C	2 # 10+ 1 # 10G - 3/4"C
					3	4					
-	SPARE	1	100	20	5	6	1	100	20	SPARE	-
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7	8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9	10	1	100	20	SPARE	-
	SPARE	2	100	30	11	12	1	100	20	SPARE	-
					13	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
	SPARE	1	100	20	15	16	1	100	20	SPARE	
-					17	18	1	100	20	SPARE	
3 # 12 + 1 # 12G - 3/4"C	SF-C (2 HP)	3	100	15	19	20	1	100	20	SPARE	
					21	22	1	100	20	SPARE	
	SPARE	1	100	20	23	24	1	100	20	SPARE	
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	25	26	1	100	20	SPARE	
	SPARE	1	100	20	27	28	1	100	20	SPARE	
	SPARE	1	100	20	29	30	1	100	20	SPARE	
	SPARE	1	100	20	31	32	1	100	20	SPARE	
	SPARE	1	100	20	33	34	1	100	20	SPARE	
	SPARE	1	100	20	35	36	1	100	20	SPARE	
	SPARE	3	100	20	37	38	3	100	20	SPARE	
					39	40					
					41	42					

N | PHASE A B C | G

1 HAGGERTY ADMINISTRATION BUILDING PANEL SCHEDULE - PP-A1

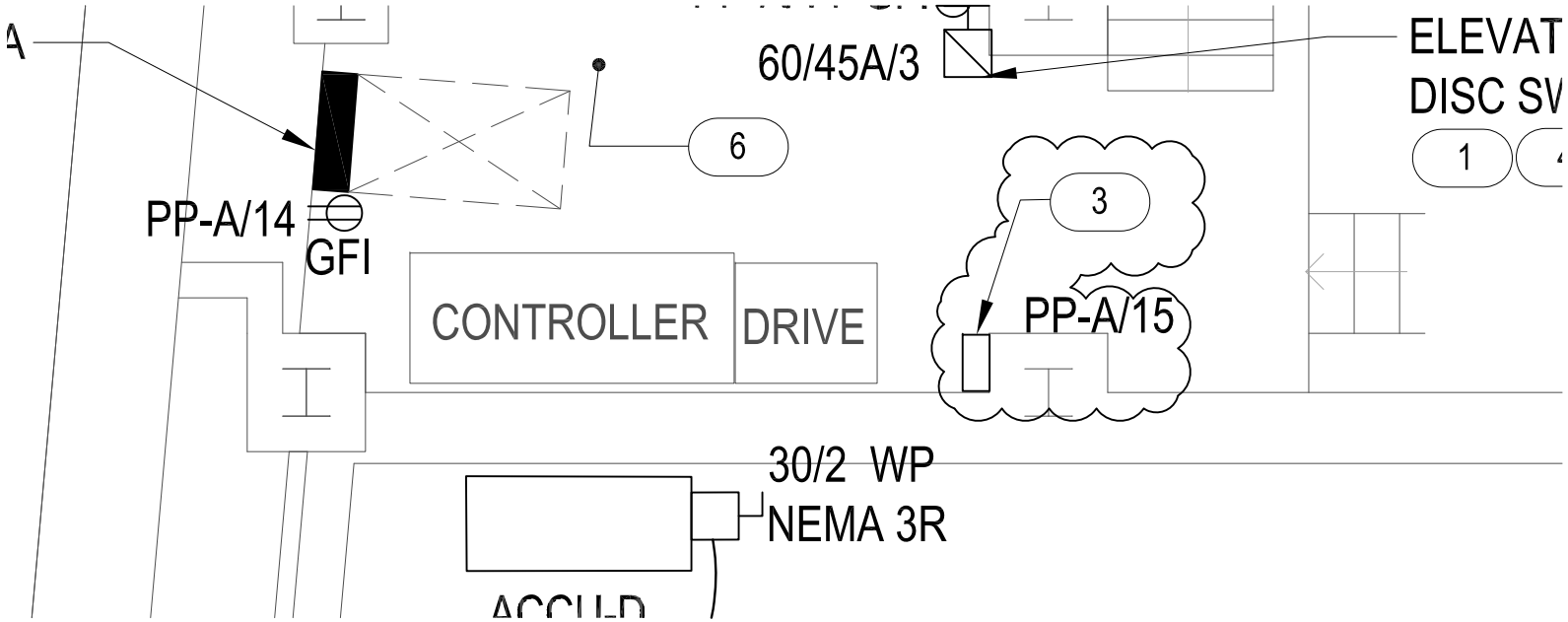
SCALE: NTS

HAGGERTY ADMINISTRATION BUILDING
HAB-SKE601.00_2

ATTACHMENT 16, ADDENDUM 6, 12/07/2022

KEY NOTES

3 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



2 LC PENTHOUSE POWER PART PLAN

SCALE: 3/8"=1'-0"

LECTURE CENTER
LC-SKE101.00_2

PANEL:	PP-A	MAIN RATING:	OPTIONS:	
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS	[ ] DOOR-IN-DOOR TRIM
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS	
AIC RATING:	10k		[ ] 200% NEUTRAL BUS	[ ] INTEGRAL TVSS DEVICE
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS	[ ] INTEGRAL RC SWITCH
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS	[ ] INTEGRAL METERING DEVICE
MOUNTING:	SURFACE			
LOCATION:	ELEVATOR MACHINE ROOM LC			

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC UNIT	2	100	15	1	2	2	100	30	ACCU -D	2 # 10+ 1 # 10G - 3/4"C
					3	4					
-	SPARE	1	100	20	5	6	1	100	20	SPARE	-
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7	8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9	10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
	SPARE	2	100	30	11	12	1	100	20	SPARE	-
					13	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	15	16					
-	SPARE	1	100	20	17	18	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
	SPARE	1	100	20	19	20					
	SPARE	1	100	20	21	22	1	100	20	SPARE	-
	SPARE	1	100	20	23	24	1	100	20	SPARE	
	SPARE	1	100	20	25	26	1	100	20	SPARE	
	SPARE	1	100	20	27	28	1	100	20	SPARE	
	SPARE	1	100	20	29	30	1	100	20	SPARE	
	SPARE	1	100	20	31	32	1	100	20	SPARE	
	SPARE	1	100	20	33	34	1	100	20	SPARE	
	SPARE	1	100	20	35	36	1	100	20	SPARE	
	SPARE	1	100	20	37	38	1	100	20	SPARE	
	SPARE	1	100	20	39	40	1	100	20	SPARE	
	SPARE	1	100	20	41	42	1	100	20	SPARE	

N — PHASE A B C — G

** GFIC CIRCUIT BREAKER

1 LECTURE CENTER PANEL SCHEDULE - PP-A

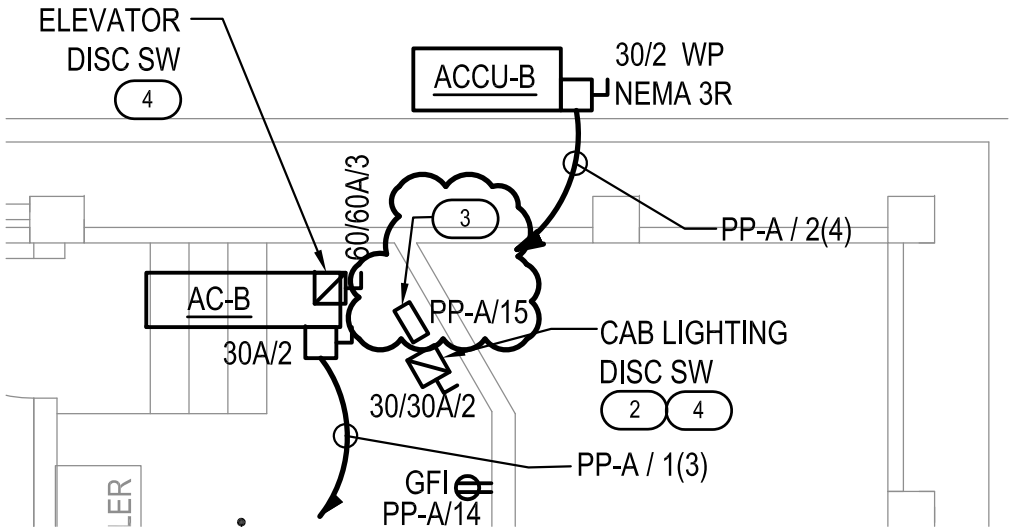
SCALE: NTS

LECTURE CENTER
LC-SKE601.00_2

ATTACHMENT 18, ADDENDUM 6, 12/07/2022

KEY NOTES

3 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



2 SAB THIRD FL POWER PART PLAN

SCALE: 1/4"=1'-0"

SMILEY ART BUILDING
SAB-SKE101.00_2

ATTACHMENT 19, ADDENDUM 6, 12/07/2022

PANEL:	PP-A	MAIN RATING:	OPTIONS:	
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS	[ ] DOOR-IN-DOOR TRIM
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS	
AIC RATING:	10k		[ ] 200% NEUTRAL BUS	[ ] INTEGRAL TVSS DEVICE
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS	[ ] INTEGRAL RC SWITCH
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS	[ ] INTEGRAL METERING DEVICE
MOUNTING:	SURFACE			
LOCATION:	ELEVATOR MACHINE ROOM	SAB		

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	N / PHASE A B C / G	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-B	2	100	15	1		2	2	100	30	ACCU-B	2 # 10+ 1 # 10G - 3/4"C
					3		4					
-	SPARE	1	100	20	5		6	1	100	20	SPARE	-
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7		8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9		10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
	SPARE	2	100	30	11		12	1	100	20	SPARE	-
					13	**	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	15		16	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
-	SPARE	1	100	20	17		18					
	SPARE	1	100	20	19		20					
	SPARE	1	100	20	21		22	1	100	20	SPARE	-
	SPARE	1	100	20	23		24	1	100	20	SPARE	
	SPARE	1	100	20	25		26	1	100	20	SPARE	
	SPARE	1	100	20	27		28	1	100	20	SPARE	
	SPARE	1	100	20	29		30	1	100	20	SPARE	
	SPARE	1	100	20	31		32	1	100	20	SPARE	
	SPARE	1	100	20	33		34	1	100	20	SPARE	
	SPARE	1	100	20	35	*	36	1	100	20	SPARE	
REFER ONLINE DIAGRAM	ELEV # 1 (15HP)	3	100	70	37		38	1	100	20	SPARE	
					39		40	1	100	20	SPARE	
					41		42	1	100	20	SPARE	

* ELEVATOR CB WITH SHUNT TRIP
** GFIC CIRCUIT BREAKER

1 SMILEY ART BUILDING PANEL SCHEDULE - PPA

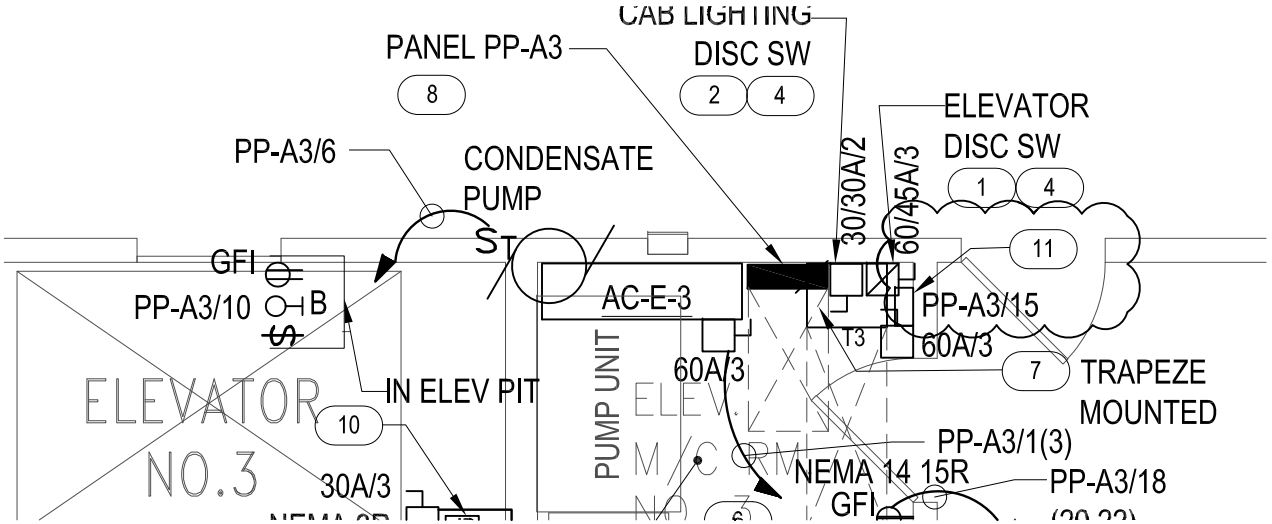
SCALE: NTS

SMILEY ART BUILDING
SAB-SKE601.00_2

ATTACHMENT 20, ADDENDUM 6, 12/07/2022

KEY NOTES (Con't)

11 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



STL CONCOURSE ELEV #3 POWER PART PLAN

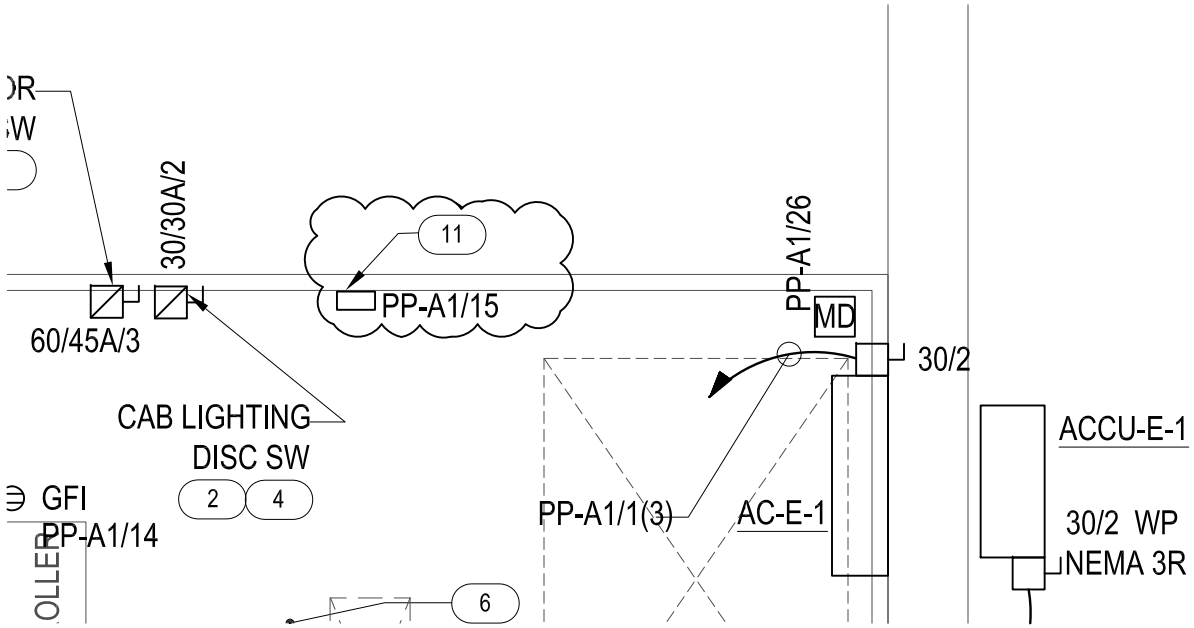
7

SCALE: 1/4"=1'-0"

SOJOURNER TRUTH LIBRARY
STL-SKE101.00_4

KEY NOTES (Con't)

11 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



STL PENTHOUSE M/C RM ELEV #1 POWER PART PLAN

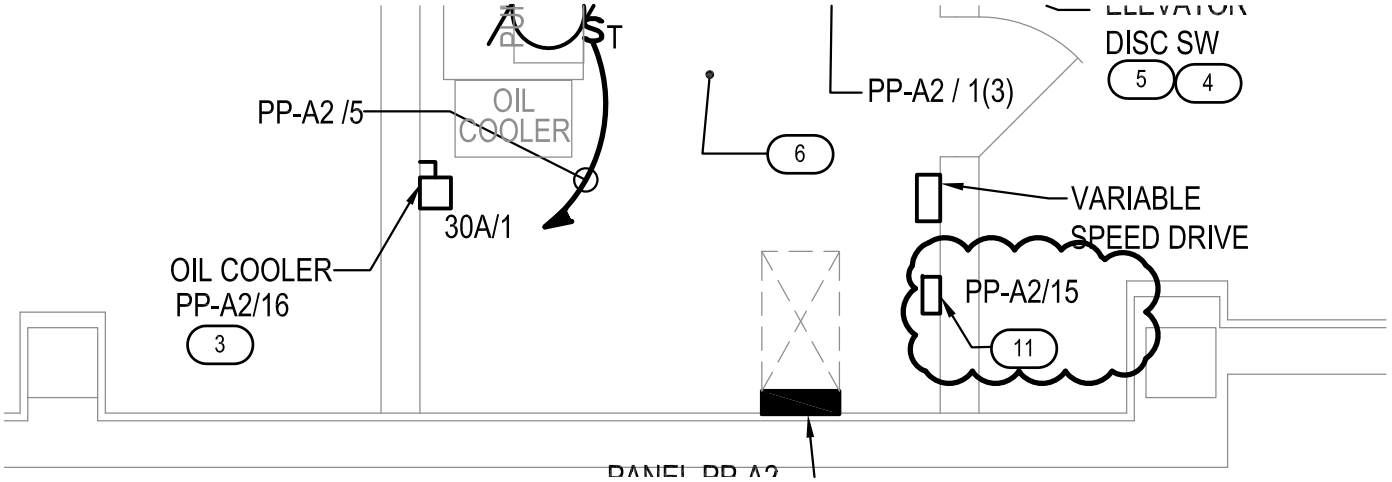
2

SCALE: 1/4"=1'-0"

SOJOURNER TRUTH LIBRARY
STL-SKE101.00_5

KEY NOTES (Con't)

11 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



5 STL GROUND FL ELEV #2 M/C ROOM POWER PART PLAN

SCALE: 1/8"=1'-0"

SOJOURNER TRUTH LIBRARY
STL-SKE101.00_6

PANEL:	PP-A1	MAIN RATING:	OPTIONS:
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS
AIC RATING:	10k		[ ] 200% NEUTRAL BUS
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS
MOUNTING:	SURFACE		[ ] DOOR-IN-DOOR TRIM
LOCATION:	ELEVATOR MACHINE ROOM STL		[ ] INTEGRAL TVSS DEVICE
			[ ] INTEGRAL RC SWITCH
			[ ] INTEGRAL METERING DEVICE

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-E-1	2	100	15	1	2	2	100	30	ACCU-E-1	2 # 10+ 1 # 10G - 3/4"C
					3	4					
-	SPARE	1	100	20	5	6	1	100	20	SPARE	-
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7	8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9	10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
	SPARE	2	100	30	11	12	1	100	20	SPARE	-
					13	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	15	16	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
-	SPARE	1	100	20	17	18					
	SPARE	1	100	20	19	20					
	SPARE	1	100	20	21	22	1	100	20	SPARE	-
	SPARE	1	100	20	23	24	1	100	20	SPARE	
	SPARE	1	100	20	25	26	1	100	20	SPARE	
	SPARE	1	100	20	27	28	1	100	20	SPARE	
	SPARE	1	100	20	29	30	1	100	20	SPARE	
	SPARE	1	100	20	31	32	1	100	20	SPARE	
	SPARE	1	100	20	33	34	1	100	20	SPARE	
	SPARE	1	100	20	35	36	1	100	20	SPARE	
	SPARE	1	100	20	37	38	1	100	20	SPARE	
	SPARE	1	100	20	39	40	1	100	20	SPARE	
	SPARE	1	100	20	41	42	1	100	20	SPARE	

N — PHASE A B C — G

** GFIC CIRCUIT BREAKER

1 SOJOURNER BUILDING PANEL SCHEDULE - PP-A1

SCALE: NTS

SOJOURNER TRUTH LIBRARY
STL-SKE601.00_2

ATTACHMENT 24, ADDENDUM 6, 12/07/2022

PANEL:	PP-A2	MAIN RATING:	OPTIONS:
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS; [ ] DOOR-IN-DOOR TRIM
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS
AIC RATING:	10k		[ ] 200% NEUTRAL BUS; [ ] INTEGRAL TVSS DEVICE
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS; [ ] INTEGRAL RC SWITCH
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS; [ ] INTEGRAL METERING DEVICE
MOUNTING:	SURFACE		
LOCATION:	ELEVATOR MACHINE ROOM	STL	

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-E-2	2	100	15	1	2	2	100	30	ACCU-E-2 & CONDENSATE PUMP	2 # 10+ 1 # 10G - 3/4"C
					3	4					
-	SPARE	1	100	20	5	6	1	100	15	CONDENSATE PUMP (1/6HP)	2#12 + 1#12G - 3/4"C
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7	8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9	10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
	SPARE	2	100	30	11	12	1	100	20	SPARE	-
					13	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	15	16	1	100	15	ELEV OIL COOLER	2 # 12+ 1 # 12G - 3/4"C
-	SPARE	1	100	20	17	18	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
	SPARE	1	100	20	19	20					
	SPARE	1	100	20	21	22					
	SPARE	1	100	20	23	24	1	100	20	SPARE	-
	SPARE	1	100	20	25	26	1	100	20	SPARE	
	SPARE	1	100	20	27	28	1	100	20	SPARE	
	SPARE	1	100	20	29	30	1	100	20	SPARE	
	SPARE	1	100	20	31	32	1	100	20	SPARE	
	SPARE	1	100	20	33	34	1	100	20	SPARE	
	SPARE	1	100	20	35	36	1	100	20	SPARE	
	SPARE	1	100	20	37	38	1	100	20	SPARE	
	SPARE	1	100	20	39	40	1	100	20	SPARE	
	SPARE	1	100	20	41	42	1	100	20	SPARE	

N | PHASE A B C | G

** GFIC CIRCUIT BREAKER

1

SOJOURNER BUILDING PANEL SCHEDULE - PP-A2

SCALE: NTS

SOJOURNER TRUTH LIBRARY
STL-SKE601.00_3

ATTACHMENT 25, ADDENDUM 6, 12/07/2022

PANEL:	PP-A3	MAIN RATING:		OPTIONS:
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS	[ ] DOOR-IN-DOOR TRIM
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS	
AIC RATING:	10k		[ ] 200% NEUTRAL BUS	[ ] INTEGRAL TVSS DEVICE
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS	[ ] INTEGRAL RC SWITCH
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS	[ ] INTEGRAL METERING DEVICE
MOUNTING:	SURFACE			
LOCATION:	ELEVATOR MACHINE ROOM STL			

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	CKT.	N	PHASE A	B	C	G	CKT.	BRANCH DEVICE POLE (No)	FRAME (AMP)	TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-E-3 & CONDENSATE PUMP	2	100	15	1						2	2	100	30	ACCU-E-3	2 # 10+ 1 # 10G - 3/4"C
					3						4					
2 # 12 + 1 # 12G - 3/4"C	EF-E-3	1	100	20	5						6	1	100	15	CONDENSATE PUMP (1/6HP)	2#12 + 1#12G - 3/4"C
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7						8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9						10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
	SPARE	2	100	30	11						12	1	100	20	SPARE	-
					13						14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	15						16	1	100	15	ELEV OIL COOLER	2 # 12+ 1 # 12G - 3/4"C
-	SPARE	1	100	20	17						18	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
	SPARE	1	100	20	19						20					
	SPARE	1	100	20	21						22					
	SPARE	1	100	20	23						24	1	100	20	SPARE	-
	SPARE	1	100	20	25						26	1	100	20	SPARE	
	SPARE	1	100	20	27						28	1	100	20	SPARE	
	SPARE	1	100	20	29						30	1	100	20	SPARE	
	SPARE	1	100	20	31						32	1	100	20	SPARE	
	SPARE	1	100	20	33						34	1	100	20	SPARE	
	SPARE	1	100	20	35						36	1	100	20	SPARE	
	SPARE	1	100	20	37						38	1	100	20	SPARE	
	SPARE	1	100	20	39						40	1	100	20	SPARE	
	SPARE	1	100	20	41						42	1	100	20	SPARE	

** GFIC CIRCUIT BREAKER

1 SOJOURNER BUILDING PANEL SCHEDULE - PP-A3

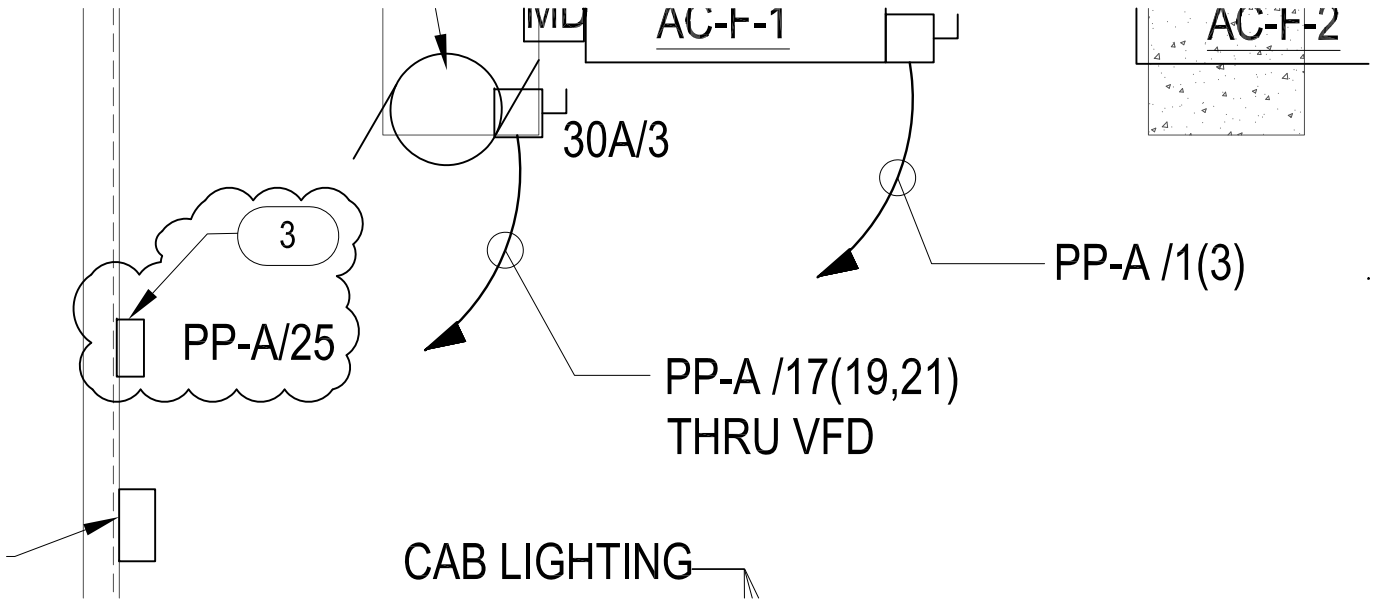
SCALE: NTS

SOJOURNER TRUTH LIBRARY
STL-SKE602.00_2

ATTACHMENT 26, ADDENDUM 6, 12/07/2022

KEY NOTES

3 CELLULAR GATEWAYS PROVIDED UNDER DIV 14



2 SUB PENTHOUSE POWER PART PLAN

SCALE: 3/8"=1'-0"

STUDENT UNION BUILDING
SUB-SKE101.00_2

PANEL:	PP-A	MAIN RATING:	OPTIONS:
SERVICE VOLTAGE:	120/208V, 3PH, 4W	[X] MCB: 100A/3P	[X] BONDED GROUND BUS
MAIN BUS RATING:	100A	[ ] MLO:	[ ] ISOLATED GROUND BUS
AIC RATING:	10k		[ ] 200% NEUTRAL BUS
PANEL FEEDER:	SEE ONE LINE DIAGRAM		[ ] FEED THROUGH LUGS
ENCLOSURE:	NEMA-1		[ ] SUB FEED LUGS
MOUNTING:	SURFACE		
LOCATION:	ELEVATOR MACHINE ROOM	SUB	

[ ] DOOR-IN-DOOR TRIM
[ ] INTEGRAL TVSS DEVICE
[ ] INTEGRAL RC SWITCH
[ ] INTEGRAL METERING DEVICE

BRANCH FEEDER	LOAD DESCRIPTION	BRANCH DEVICE POLE (No)	BRANCH DEVICE FRAME (AMP)	BRANCH DEVICE TRIP (AMP)	CKT.	CKT.	BRANCH DEVICE POLE (No)	BRANCH DEVICE FRAME (AMP)	BRANCH DEVICE TRIP (AMP)	LOAD DESCRIPTION	BRANCH FEEDER
2 # 12 + 1 # 12G - 3/4"C	AC-F-1	2	100	15	1	2	2	100	30	ACCU-F-2	2 # 10+ 1 # 10G - 3/4"C
					3	4					
-	SPARE	1	100	20	5	6	1	100	20	SPARE	-
3 # 10 + 1 # 10G - 1"C	ELEV CAB VENTILATION AND LIGHTING DISCONNECT SWITCH	2	100	30	7	8	1	100	20	ELEV M/C ROOM LIGHTING	2 # 12+ 1 # 12G - 3/4"C
					9	10	1	100	20	ELEV PIT REC+LIGHTING	2 # 12+ 1 # 12G - 3/4"C
2 # 12 + 1 # 12G - 3/4"C	AC-F-2	2	100	15	11	12	1	100	20	SPARE	-
					13	14	1	100	20	RECEPTACLE M/C ROOM	2 # 12+ 1 # 12G - 3/4"C
	SPARE	1	100	20	15	16	1	100	20	ELEV EMER PANEL RECEPTACLE	2 # 12+ 1 # 12G - 3/4"C
3 # 12 + 1 # 12G - 3/4"C	SF-F (1 1/2 HP)	3	100	15	17	18	1	100	20	SPARE	
					19	20	3	100	15	SUMP PUMP SP-A (4.4A/1.6KW) & CONTROL PANEL RECEPTACLE	3 # 12+ 1 # 12G - 3/4"C
					21	22					
	SPARE	1	100	20	23	24					
2 # 12 + 1 # 12G - 3/4"C	CELLULAR GATEWAYS	1	100	20	25	26	1	100	20	SPARE	-
	SPARE	1	100	20	27	28	1	100	20	SPARE	
	SPARE	1	100	20	29	30	1	100	20	SPARE	
	SPARE	1	100	20	31	32	1	100	20	SPARE	
	SPARE	1	100	20	33	34	1	100	20	SPARE	
	SPARE	1	100	20	35	36	1	100	20	SPARE	
	SPARE	1	100	20	37	38	1	100	20	SPARE	
	SPARE	1	100	20	39	40	1	100	20	SPARE	
	SPARE	1	100	20	41	42	1	100	20	SPARE	

N — PHASE A B C — G

** GFIC CIRCUIT BREAKER

1 STUDENT UNION BUILDING PANEL SCHEDULE - PP-A

SCALE: NTS

STUDENT UNION BUILDING
SUB-SKE601.00_2

ATTACHMENT 28, ADDENDUM 6, 12/07/2022