

**SECTION 009112
ADDENDUM NUMBER 3**

PARTICULARS

1.01 DATE: JUNE 10, 2021

1.02 PROJECT: 20074.01 MTC BSC CHILLER REPLACEMENT - BELTLINE CAMPUS

TO: PROSPECTIVE BIDDERS:

2.01 THIS ADDENDUM FORMS A PART OF THE CONTRACT DOCUMENTS AND MODIFIES THE ORIGINAL PROCUREMENT DOCUMENTS DATED MAY 3, 2021, WITH AMENDMENTS AND ADDITIONS NOTED BELOW.

2.02 ACKNOWLEDGE RECEIPT OF THIS ADDENDUM IN THE SPACE PROVIDED IN THE BID FORM. FAILURE TO DO SO MAY DISQUALIFY THE BIDDER.

2.03 THIS ADDENDUM CONSISTS OF 1 PAGE AND THE FOLLOWING ATTACHMENTS, SPECIFICATIONS, AND DRAWINGS:

A. 23 0548 - Vibration and Seismic Controls HVAC

B. M0.1 - HVAC LEGENDS, NOTES, ABBREVIATIONS, AND SCHEDULES

CHANGES TO THE PROJECT MANUAL - SPECIFICATIONS:

3.01 SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS HVAC

A. Delete section in its entirety and replace with attached 23 0548.

CHANGES TO DRAWINGS:

4.01 DRAWING M0.1-HVAC LEGENDS, NOTES, ABBREVIATIONS, AND SCHEDULES

A. Make revisions to drawings as indicated.

END OF SECTION

**SECTION 230548
VIBRATION AND SEISMIC CONTROLS HVAC**

PART 1: GENERAL

1.01 SEISMIC AND WIND RESTRAINTS

- A. General:
1. Provide positive seismic and wind restraints on systems and components required by the applicable building code and by the local authority having jurisdiction. This section covers design, supply, installation and inspection of complete SFRS {Seismic Force Resisting System} for all systems.
 2. See the vibration isolation and seismic restraint schedule for equipment specific values to be used in calculating the seismic restraint forces, including component importance factor, (IE) / (IP); Reference Code By Jurisdiction.
 3. Provide restraint devices as required, specified, and as scheduled for isolated and non-isolated systems and equipment. Provide calculations to determine restraint loadings for all restrained systems and equipment resulting from seismic forces. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years experience in the design of seismic restraints.
- B. The contractor shall utilize a supplier familiar/experienced with the design of seismic systems to provide a comprehensive package of isolation and seismic restraint for the project. Provide detailed shop drawings showing the proposed restraint system for all required equipment, piping and ductwork on the project. The shop drawings shall include calculations certified by a registered design professional.
1. Seismic restraints are to be provided for all mechanical & non-structural components of building services in accordance with the current: IBC; NBCC; OBC; ASHRAE Standards "A Practical Guide to Seismic Restraints"; NFPA 13; SMACNA (2nd Edition) "HVAC Duct Construction Standards" and Good Engineering Practice (references listed below):
 - a. SMACNA (Sheet Metal and Air-conditioning Contractors' National Association's) Seismic Restraint Manual Guidelines for Mechanical Systems (2nd ed. Or 3rd ed. depending on specified either by code or Engineer of Record).
 - b. ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint; ASHRAE Applications Handbook, Seismic and Wind Restraint Design Chapter; ASHRAE Standard 171-2008: Methods of Test for Seismic restraints.
 - c. VISCMA (The Vibration Isolation and Seismic Control Manufacturers Association) has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.
 - d. VISCMA 102-2007: Static Qualification Standards for Obtaining a VISCMA Compliant Seismic Component Rating.
 - e. FEMA (Federal Emergency Management agency) Seismic Restraint Installation Manuals 412, 413 & 414.
 - 1) FEMA 412: Installing Seismic Restraints for Mechanical Equipment.
 - 2) FEMA 413: Installing Seismic Restraints for Electrical Equipment.
 - 3) FEMA 414: Installing Seismic Restraints for Duct and Pipe.
 2. Each contractor shall use a single manufacturer to provide and certify seismically rated isolators and restraints. Preferred manufacturer is: Kinetics Noise Control, Inc.
 3. At the completion of the project, upon request, there can be a review of the installations on site and a sealed written report, certifying that the installations have been completed in accordance with the specified design(s) and shop drawing(s) can be furnished, by others, upon this request.

1.02 ENGINEERING PERFORMANCE REQUIREMENTS

- A. Specified design criteria for seismic and vibration for elements and components are to be designed to accommodate these specific calculation components factors:
1. Refer to structural drawings for Seismic Criteria.
 2. Design (Site Class) Soil Type (D) as appropriate.
 3. Importance or Performance Factor appropriate to structure (IP = 1.5)
 4. Equipment Schedule (IBC / NBCC / OBC, TI-808-04, 97UBC) The Mechanical Engineer of record will provide a comprehensive Equipment Schedule indicating

individual equipment importance factors, IP / IE, (including equipment whose importance factor, IP / IE, may be increased by proximity to essential life safety or hazardous components), equipment elevation both in the structure and (if floor mounted, relative to the floor), roof elevation and structural interface material, i.e., anchored to concrete, bolted or welded to steel.

5. Schedule or drawings indicating critical (IP =1.5) / (IE =1.5) Duct / Piping systems, including systems whose importance factor may be increased by proximity to critical components.
6. Wind loads shall be based on the requirements listed in ASCE 7-05 including the recommendations in the commentary for that document.

1.03 SEISMIC DESCRIPTION OF SYSTEM

- A. It shall be understood that the requirements of this seismic restraint section are in addition to other requirements as specified elsewhere for the support and attachment of equipment and mechanical services, and for the vibration isolation of same equipment. Nothing on the project drawings or specifications shall be interpreted as justification to waive the requirements of this seismic restraint section.
 1. Seismic restraint systems shall be designed to offer seismic restraint in all directions, unless otherwise noted.
 2. Anchor types and sizes are to be per the design data as provided by the seismic restraint manufacturer.
 3. Seismic restraint capacities, seismic cable restraint system, rod stiffener clamps to be verified by an independent test laboratory or certified by a registered design professional to ensure that the design intent of this specification is realized. Verification shall be by one of the following methods:
 - a. An NRTL (National Recognized Testing Laboratory), or laboratory recommended by VISCMA.
 - b. Certified by a registered design professional with at least 5 years experience, using industry standard methods of analysis, which employ common engineering practices. Adherence to the ratings standard within ASHRAE Standard 171-2008 and VISCMA 102-2007 is required.
 - c. By a nationally recognized agency, such as VISCMA, that has reviewed and approved the restraint.
- B. Its the contractors' responsibility to ensure the seismic engineers' requirements have been met.

1.04 SEISMIC SYSTEM DESIGN

- A. The seismic restraint manufacturer shall be responsible for the selection of the attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.
- B. The contractor shall furnish, to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, and installed operating weights of the equipment to be restrained.
- C. All piping and ductwork is to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as "worst case" reaction loads for each restraint and/or anchor size.
- D. The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size & thickness of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances & embedment depths exist in order to obtain the desired equipment anchor capacities.

1.05 COORDINATION

- A. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi, more if so specified by the project engineer.

- B. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment).

1.06 SUBMITTALS

- A. All seismic / wind / vibration restraint systems shall be by a single manufacturer.
- B. Product Data: Include Seismic Rating Data for each seismically rated isolator or restraint component.
- C. Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachment(s) and anchorage requirements. Shop Drawings shall include the following:
 - 1. Design Calculations: Calculate the load requirements for all seismically rated vibration isolators and seismic restraints. Certification documents to be signed and sealed by a registered design professional with at least 5 years experience in the design of seismic restraint systems.
 - 2. Vibration Isolation Bases: Dimensional drawings including anchorage and attachment to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads.
 - 3. Seismic-Restraint Details: Provide detailed submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include load rating where appropriate.
 - 4. Equipment Manufacturer Seismic Qualification Certification: The Equipment Manufacturer must submit certification that each piece of provided equipment will withstand seismic forces identified in "Performance Requirements"; Include the following:
 - a. Basis for Certification: Indicate whether the "withstand" certification is based on actual test of assembled components or on calculations.
 - b. Indicate the equipment is certified to be durable enough to:
 - 1) structurally resist the design forces (non-essential equipment) and/or
 - 2) will remain functional after the seismic event (essential equipment).
- D. Working drawings, materials lists, schematics and full specifications for all components of each SFRS to be provided. Design calculations are to include restraint loads resulting from seismic forces in accordance with {IBC / NBSS / OBC}, detailed work sheets and tables as appropriate. Separate shop drawings for each SFRS and devices for each system or equipment are to be provided. These drawings shall be designed and bear the signed stamp of a registered design professional licensed to practice in the appropriate discipline and in the projects geographic location.
- E. Materials and systems specified herein and detailed or scheduled on the drawings are based upon materials manufactured by: Kinetics Noise Control, Inc. Materials and systems provided by other manufacturers are acceptable, provided that they meet all requirements as listed in this specification.

PART 2: PRODUCTS / MATERIALS

2.01 SEISMIC RESTRAINT ISOLATION {ALL SEISMICALLY RATED ISOLATORS SELECTED FOR USE ON THE PROJECT SHALL BE CAPABLE OF WITHSTANDING THE APPLICABLE SEISMIC DESIGN FORCES FOR THE SPECIFIC INSTALLATION}.

- A. Isolators:
 - 1. ASHRAE TYPE 4 - Vibration/Seismic Spring Floor Mounts: Type FHS – Spring isolators shall be seismically restrained spring isolators, incorporating a single vibration isolator. Springs shall be restrained using a housing engineered to limit both lateral and vertical movement of the supported equipment during an earthquake without degrading the vibration isolation of the spring during normal equipment operating conditions. Vibration isolators shall incorporate a steel housing and snubbing grommet system designed to limit motion to approximately 0.2" (5 mm) in any direction and to prevent any direct metal-to-metal contact between the supported member and the fixed housing. Where the capacity of the anchorage hardware in concrete is inadequate for the required seismic loadings, an adapter plate to allow the

addition of more or larger anchors will be fitted to fulfill these requirements. In addition to the primary isolation spring, the load path will include a minimum 0.25" (6 mm) thick neoprene pad. Spring elements shall be color coded or otherwise easily identified. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be epoxy powder coated and shall have a minimum of a 1000-hour rating when tested in accordance with ASTM B-117 to facilitate servicing. Spring elements shall meet all the specified characteristics described in Section 2.1/E.1 paragraph (23 05 48 Vibration Isolation Section). Oversized base plates may be required and will be determined when seismic certifications are performed. Spring isolators shall be Model FHS as manufactured by Kinetics Noise Control, Inc.

2.02 SEISMIC RESTRAINTS {TYPES OF}

- A. SEISMIC RESTRAINT DEVICES: {DEVICES SHALL BE CAPABLE OF WITHSTANDING THE APPLICABLE DESIGN FORCES FOR THE SPECIFIC INSTALLATION}.
1. Seismic Cable Restraints: Seismic wire rope cable restraints shall consist of steel wire strand cables, sized to resist project seismic loads, arranged to offer seismic restraint capabilities for piping, ductwork, and suspended equipment in all lateral directions. Building and equipment attachment brackets at each end of the cable shall be designed to permit free cable movement in all directions up to a 45-degree misalignment (Angle is determined from the point of attachment to the structure). Protective thimbles shall be used at sharp connection points as required to eliminate potential for dynamic cable wear and strand breakage. Restraints shall be sized based on the capacity of the cable or to the capacity of the anchorage, whichever is the lesser. Seismic wire rope connections shall be made using overlap wire rope "U" clips or seismically rated Kinetics Quakeloc. Vertical suspension rods shall be braced as required to avoid potential for buckling due to vertical 'up' forces. Braces shall be structural steel angle uniquely selected to be of sufficient strength to prevent support rod bending. Brace shall be attached to the vertical suspension rod by a series of adjustable clips. Clips shall be capable of securely locking brace to suspension rod without the need for hand tools. Where clevis hanger brackets are used for seismic restraint attachment, they will be fitted with clevis internal braces to prevent buckling of the hanger brackets. Seismic cable(s) with use of "U" clips & or Kinetics Quakelocs shall be as manufactured by Kinetics Noise Control, Inc.
 - a. Seismic cable building and equipment attachment brackets shall be Model KSUA or KSCA as manufactured by Kinetics Noise Control, Inc.
 - b. Seismic cable concrete anchor bolts shall be Model KCAB Wedge, Model KCCAB Cracked Concrete, Model KUAB Undercut or KAABC Adhesive, as manufactured by Kinetics Noise Control, Inc.
- B. Hanger Rod Stiffener: Type KHRC – Seismic rod stiffener angle bracing shall be securely attached to hanging thread rod by a series of attachment clamps. Attachment clamps shall be manufactured from a one piece metal stamping, and shall include all required attachment hardware and locking nuts. Attachment clamps shall be bright zinc plated for corrosion protection. Attachment clamps shall be capable of installation or removal without the need to disassemble the suspended equipment. Attachment clamps made from aluminum, or iron castings can be brittle and shall not be acceptable for use in seismic applications. Seismic rod stiffener angle attachment clamps shall be capable of attaching angles ranging in size from 1" x 1" x 1/2" thick up to 2-1/2" x 2-1/2" x 1/4" thick, to threaded rod ranging in size from 3/8" to 1-1/2" diameter. Seismic rod stiffener angle attachment clamps shall include locking hardware to prevent any potential for loosening due to (piping) (ductwork) (suspended equipment) operational vibration. Seismic clamps shall be capable of installation using common hand tools, with no specialized or unique installation tools required. Steel angle to be provided by contractor; steel clamp to be provided by seismic restraint manufacturer. Seismic rod stiffener angle attachment clamps shall be Model KHRC as manufactured by Kinetics Noise Control, Inc.
- C. Seismic Beam Clamps: Type KSBC – The Kinetics Noise Control KSBC Beam Clamp is designed to address the horizontal loads expected from seismic events. The two (2) sizes available use 3/8" and 1/2" attachment hardware and are equivalent to full bolted connections for hardware of the same size. (Thus if documentation requires that a 3/8" bolt be used, a 3/8" beam clamp is equally acceptable.) Seismic beam clamps shall be Model KSBC as manufactured by Kinetics Noise Control, Inc.

- D. Seismic Restraint Brackets: Type KSMS / KSMG – Formed steel brackets for securing floor-mounted equipment complete with pre-drilled holes. Brackets shall be galvanized or powder coated enamel for corrosion protection. Selection of KSMS / KSMG size, quantity and locations is included as part of the seismic or wind restraint calculations provided by Kinetics Noise Control, Inc. Seismic brackets shall be Model KSMS / KSMG as manufactured by Kinetics Noise Control, Inc.
- E. Seismic Restraint Brackets (Curb-Mounted): Type KSMF – Seismic Mushroom Fan Mounting Clips are seismic and wind restraint brackets used to solid-mount mushroom fans to the curb. Attachment of the curb to the building structure is the responsibility of others. The clips are attached to the fan and the curb with sheet metal screws. The KSMF can also be used for similar sized curb-mounted fans and equipment. Selection of Model KSMF quantity and locations is included as part of the seismic or wind restraint calculations provided by Kinetics Noise Control, Inc.
- F. Seismic Snubbers: Structural steel angle(s) with surfaces covered with ribbed neoprene pads to cushion contact with snubber. Customized snubber designs may use other structural shapes and configurations as required. Snubbers shall be designed to limit equipment motion to no more than 6 mm (1/4”) in any direction.
 - 1. TYPE KRMS (3-axis): The KRMS is a neoprene isolator with a 3-axis restraint capability. The deflection of the isolators in the, confined mode, will be between 0.25” and 0.33” depending on the rated load. The natural frequency if loaded to the rated value would be between 6.25 Hz and 5.45 Hz. Three-axis seismic neoprene isolator restraint shall be Model KRMS as manufactured by Kinetics Noise Control Inc.
- G. Concrete Anchor Bolts: Post-installed anchors in concrete shall be qualified for seismic restraint application in accordance with ACI 355.2.
 - 1. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated/carbon steel for interior applications and stainless steel for exterior applications. The seismic certification by Kinetics Noise Control, Inc. uses the models: KCAB Wedge type anchor (only this anchor meets the {8X} embedment depth requirement); KCCAB Cracked Concrete type anchor; KUAB Undercut heavy-duty concrete type anchor. Any anchors that are substituted and/or supplied by others must be evaluated and approved by the design professional of record.
- H. Grommet Washers: Type TG - neoprene grommet washers, 80 durometer, of sufficient size to accommodate USS standard washers, long enough to sleeve through 6 mm (1/4”) plate material, and with at least 3 mm (1/8”) thick material around the bolt hole. Anchor bolt isolation grommet shall be Model TG as manufactured by Kinetics Noise Control, Inc.

PART 3: EXECUTION

3.01 COORDINATION AND EXECUTION

- A. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

3.02 HOUSEKEEPING PADS MUST BE ADEQUATELY REINFORCED AND ADEQUATELY SIZED FOR PROPER INSTALLATION OF EQUIPMENT ANCHORS. REFER SEISMIC RESTRAINT MANUFACTURER’S WRITTEN INSTRUCTIONS.

- A. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer’s written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer’s written instructions.
- B. Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

- C. Attach piping to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.
- D. Do not brace or support equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a Transverse restraint to a wall and then a Longitudinal restraint to either a floor/ceiling/roof at the same braced location.
- E. Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.

3.03 SEISMIC RESTRAINTS APPLICATION

- A. General:
 - 1. All equipment, piping and ductwork shall be restrained to resist seismic forces per the applicable building code(s) as a minimum; listed herein. Additional requirements specified herein are included specifically for this project; as needed basis.
 - 2. Install seismic restraint devices per the manufacturer's submittals. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.
 - 3. Attachment to structure for suspended equipment, pipe and duct: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
 - 4. Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces. {web based tools to allow easy selections are available on the KNC web site}.
 - 5. Where rigid restraints are used on equipment, ductwork or piping, the support rods for the equipment, ductwork or piping at restraint locations must be supported by anchors rated for seismic use. Post-installed concrete anchors must be in accordance with ACI 355.2.
 - 6. Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure.
- B. Concrete Anchor Bolts:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre- or post-tensioned tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Mechanical Anchors: Protect threads from damage during anchor installation.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust per manufactures instructions prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
- C. Equipment Restraints:
 - 1. Seismically restrain equipment as indicated on the schedule. Install fasteners, straps and brackets as required to secure the equipment.
 - 2. As indicated on the schedule, install seismic snubbers on HVAC equipment supported by floor-mounted, non-seismic vibration isolators. Position snubbers as necessary and attach to equipment base and supporting structure as required.
 - 3. Install neoprene grommet washers or fill the gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 3.2 mm (0.125 inch).
 - 4. Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:
 - a. Rigidly attached to pipe or duct that is 75 lbs. and greater,
 - b. Items hung independently or with flexible connections greater than 20 lbs.. For importance factors greater than {1.0} all suspended equipment requires seismic

- restraints regardless of the above notes.
- c. Wall mounted equipment weighing more than 20 lbs. with an importance factor of {1.0}.
 - d. The 12" rule does not apply to suspended equipment.
5. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified the supplier:
 - a. Connections to or containing hazardous material,
 - b. With an overturning moment,
 - c. Weight greater than 400 lbs.,
 - d. Mounted on a stand 4 ft. or more from the floor.
 - e. For importance factors greater than {1.0} all base mounted items require seismic restraints regardless of the above notes.
 6. Roof Mounted Equipment: Needs to be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.
 7. Rigid Mounted Equipment:
 8. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.
 9. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.
 10. Vibration Isolated Equipment:
 11. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
 12. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8" gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.
- D. Piping; Duct; Electrical Systems: {Provide seismic control measures with spacing and anchorage engineered for the specific project}.
1. All piping, duct electrical systems are to be restrained to meet code requirements.
 - a. All piping associated with "Life Safety Systems" shall always have an importance factor of {1.5}. Seismic restraint requirements / exemptions vary with code and seismic acceleration – see specific code and comply with applicable restraint requirements.
 - b. All piping systems (regardless of type of pipe) assigned a component importance factor of {1.5} shall require seismic restraints. Seismic restraint requirements / exemptions vary with code and seismic acceleration – see specific code and comply with applicable restraint requirements.
 - c. Seismically restrain / brace all pipes 65 mm (2 1/2") in nominal diameter and larger.
 - d. Seismically restrain / brace all piping in boiler rooms, mechanical rooms and refrigeration mechanical rooms 32 mm (1 1/4") in nominal diameter and larger.
 - e. Seismically restrain / brace all Gas (ie: natural gas, medical gas, vacuum, petroleum based liquid, compressed air, etc.) piping 25 mm (1") in nominal diameter and larger.
 - f. Branch lines may not be used to brace main lines.
 2. Restraint Spacing For Piping:
 - a. For ductile piping: Transverse supports a maximum of 12 m (40') o.c.
 - b. For ductile piping: Longitudinal supports a maximum of 24 m (80') o.c.
 - c. For non-ductile piping (e.g., cast iron, PVC) space Transverse supports a maximum of 6 m (20') o.c., and Longitudinal supports a maximum of 12 m (40') o.c. Differential spacing can be designed depending upon pipe size and length(s) of run (design will be indicated on drawings of approved method).
 - d. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 6 m (20') o.c., and Longitudinal supports a maximum of 12 m (40') o.c.
 - e. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.

3. To ensure that the seismic forces are transferred properly to the restraint points, the cables should be strapped either individually or in bundles to the cable tray at regular intervals. It is necessary for the conduit, bus ducts, and cable trays to be attached to the trapeze bars sufficiently to resist the design horizontal seismic forces, both transverse (T) and longitudinal (L).
4. Brace a change of direction longer than 3.7 m (12').
5. This specification does not allow the use of the "12-inch rule" where the piping, duct and electrical may be exempted from seismic restraint based on the length of the support rods provided that the rods are not subjected to bending moments.
6. Install restraint cables so they do not bend across edges of adjacent equipment or building structure. Tie back to structure at {45 degrees} to the structure.
7. Longitudinal restraints for single pipe supports shall be attached rigidly to the pipe, not to the pipe hanger.
8. For supports with multiple pipes (trapezes), secure pipes to trapeze member with clamps approved for application.
9. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.
10. Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.
11. Where pipe sizes reduce below required dimensions noted above in Section 3.2.E, the final restraint shall be installed at the transition location.
12. Rod Stiffener Clamps are required where the hanger rod exceeds the maximum length shown in the seismic calculation sheets. They are only required at restraint locations.
13. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.
14. Adjust restraint cables so that they are not visibly slack. Cable not to support weight during normal operation.
15. Seismic systems are to be compatible with requirements for anchoring and guiding of systems.
16. Drilled or power driven anchors or fasteners shall not be permitted for use with seismic control measures.
17. Friction due to gravity does not constitute a seismic attachment.
18. Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.
19. Standard beam clamps can be used to support restrained components; they cannot be used to connect the seismic restraint to the structure – only for the hanger rods.
20. Brace remaining piping, ductwork, electrical components to code requirements (IBC) or in conformance with SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", 2nd ed. or 3rd ed. (Depending on Code or EOR).

3.04 INSPECTION AND CERTIFICATION

- A. The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.
- B. The contractor shall notify the local representative of the seismic restraint materials manufacturer mid-way through the listed project if they require an inspection of any and all vibration and seismic restraint devices already installed. A written report of any installation errors, improperly selected devices, or other fault in the system which could affect the performance of the system shall be documented and the contractor shall perform all steps that are required from this written report to properly complete the vibration and seismic restraint work as per the specifications.
- C. Upon completion of the installation, arrange for an independent 3rd party registered design professional, upon request, is to visit the site to verify the proper installation of all seismic restraint devices herein specified. The local representative of the vibration manufacturer shall, at the contractor's request, be present as well to support the independent professional in the inspection of the completed system. A written report citing any installation errors, improperly selected devices, or other fault in the system which could

affect the performance of the system should be generated by the 3rd party professional. Also, the local representative shall verify that isolators are adjusted, with spring's perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

- D. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

END OF SECTION

MECHANICAL SYSTEMS SEISMIC AND WIND REQUIREMENTS PER IBC-2018/ASCE 7-16				
A.	PER THE 2018 INTERNATIONAL BUILDING CODE, MECHANICAL, PLUMBING AND ELECTRICAL EQUIPMENT AND COMPONENTS, INCLUDING THEIR SUPPORTS AND ATTACHMENTS, SHALL BE DESIGNED FOR SEISMIC FORCES IN ACCORDANCE WITH CHAPTER 13 OF ASCE 7-16.			
B.	EXTERIOR EQUIPMENT (INCLUDING ROOF CURBS, RAILS, SUPPORTS) EXPOSED TO WIND SHALL BE DESIGNED AND INSTALLED TO RESIST THE WIND PRESSURES DETERMINED IN ACCORDANCE WITH CHAPTER 28 TO 29 OF ASCE 7-16.			
C.	WHERE DESIGN FOR SEISMIC AND WIND LOADS IS REQUIRED, THE MORE DEMANDING FORCE MUST BE USED.			
D.	REFERENCE THE STRUCTURAL DRAWINGS FOR SITE SPECIFIC INFORMATION ON SEISMIC DESIGN CATEGORY, WIND SPEEDS, ETC.			
E.	USE THE TABLE BELOW TO DETERMINE SEISMIC RESTRAINT REQUIREMENTS FOR EACH COMPONENT.			
F.	FOR ALL COMPONENTS REQUIRING SEISMIC RESTRAINT, THE COMPONENT SUPPORTS AND ATTACHMENTS SHALL BE DESIGNED BY A REGISTERED DESIGN PROFESSIONAL REGISTERED IN THE STATE THE JOB IS LOCATED. SUBMITTALS MUST INCLUDE STAMPED AND SIGNED DRAWINGS AND CALCULATIONS.			
G.	WHERE SEISMIC RESTRAINT IS REQUIRED, HOUSEKEEPING PADS NEEDED FOR THE INSTALLATION OF EQUIPMENT UNDER THIS CONTRACT MUST BE DESIGNED BY THE SEISMIC ENGINEER. DO NOT POUR ANY HOUSEKEEPING PADS PRIOR TO THE RECEIPT OF THE APPROVED SEISMIC SUBMITTAL.			
H.	SEISMIC RESTRAINTS FOR DUCTWORK, PIPING, CONDUIT, CABLE TRAYS AND BUS DUCT MUST BE SHOWN ON LAYOUT DRAWINGS SHOWING SPECIFIC RESTRAINT LOCATIONS ALONG WITH ACCOMPANYING DETAILS AND CALCULATIONS.			
MECHANICAL COMPONENT IMPORTANCE FACTOR (Ip) DESIGNATION				
Ip=1.0		Ip=1.5		
ALL HVAC COMPONENTS				
SEISMIC DESIGN CATEGORIES D,E,F				
COMPONENT IMPORTANCE FACTOR (Ip)				
Ip=1.0		Ip=1.5		
COMPONENT IDENTIFICATION	SEISMIC RESTRAINT REQUIREMENT	NOTES	SEISMIC RESTRAINT REQUIREMENT	NOTES
ROOF MOUNTED	RESTRAIN ALL	1	RESTRAIN ALL	-
FLOOR MOUNTED	RESTRAIN ALL	1.2	RESTRAIN ALL	-
WALL MOUNTED	RESTRAIN ALL	1.2	RESTRAIN ALL	-
COMPONENT SUPPORTS	RESTRAIN ALL	1	RESTRAIN ALL	-
SUSPENDED EQUIPMENT	IN LINE WITH DUCT	RESTRAIN IF >75 LBS PROVIDE FLEX. CONN.	3	RESTRAIN IF >75 LBS PROVIDE FLEX. CONN.
	NOT IN LINE WITH DUCT/PIPE	RESTRAIN ALL	1	RESTRAIN ALL
SUSPENDED DUCTILE PIPING (STEEL, ALUMINUM, COPPER, ETC.)		>3"	4	>1"
SUSPENDED NON DUCTILE PIPING (CAST IRON, PLASTIC, CERAMIC)		RESTRAIN ALL	4	RESTRAIN ALL
SUSPENDED PIPE ON TRAPEZE	RESTRAIN IF ANY PIPE ON TRAPEZE > 3" RESTRAIN IF TOTAL WEIGHT OF PIPES ON TRAPEZE > 10 LBS/FT	4	RESTRAIN IF ANY PIPE ON TRAPEZE > 1" RESTRAIN IF TOTAL WEIGHT OF PIPES ON TRAPEZE > 10 LBS/FT	4
DUCTWORK	6 SQ.FT. AND LARGER AND > 17 LBS/FT	4.5	6 SQ.FT. AND LARGER AND > 17 LBS/FT	4.5
MULTIPLE DUCTS ON TRAPEZE	RESTRAIN IF TOTAL WEIGHT OF DUCTS ON TRAPEZE > 10 LBS/FT	4.5	RESTRAIN IF TOTAL WEIGHT OF DUCTS ON TRAPEZE > 10 LBS/FT	3.4
COMPONENT CERTIFICATION	NOT REQUIRED	-	REQUIRED	6
NOTES:				
1. EQUIPMENT 20 LBS. OR LESS IS EXEMPT IF THE COMPONENT IS POSITIVELY ATTACHED TO THE STRUCTURE AND FLEXIBLE CONNECTIONS ARE PROVIDED BETWEEN THE COMPONENT AND ASSOCIATED DUCTWORK, PIPING, AND CONDUIT.				
2. RESTRAINTS ARE NOT REQUIRED IF THE COMPONENT WEIGHS 400 LBS. OR LESS, IS MOUNTED WITH THE CENTER OF MASS LOCATED AT 4 FT. OR LESS ABOVE A FLOOR, IS POSITIVELY ATTACHED TO THE STRUCTURE AND HAS FLEXIBLE CONNECTIONS BETWEEN THE COMPONENT AND ASSOCIATED DUCTWORK, PIPING, AND CONDUIT.				
3. FLEXIBLE CONNECTIONS REQUIRED FOR PIPE CONNECTIONS ONLY.				
4. RESTRAINT IS NOT REQUIRED IF THE PIPING / DUCTWORK IS SUPPORTED BY HANGERS AND EACH HANGER IN THE PIPING RUN IS 12 IN. OR LESS IN LENGTH FROM THE TOP OF THE PIPE TO THE SUPPORTING STRUCTURE. WHERE PIPES ARE SUPPORTED ON A TRAPEZE, THE TRAPEZE SHALL BE SUPPORTED BY HANGERS HAVING A LENGTH OF 12 IN. OR LESS. WHERE ROD HANGERS ARE USED, THEY SHALL BE EQUIPPED WITH SWIVELS, EYE NUTS OR OTHER DEVICES TO PREVENT BENDING IN THE ROD.				
5. ALL DUCTWORK, REGARDLESS OF SIZE, DESIGNED TO CARRY TOXIC, HIGHLY TOXIC, OR EXPLOSIVE GASES OR USED FOR SMOKE CONTROL MUST BE RESTRAINED.				
6. COMPONENT CERTIFICATION MUST BE SUPPLIED BY THE EQUIPMENT MANUFACTURER AT TIME OF SUBMITTAL FOR REVIEW BY ENGINEER OF RECORD.				

VIBRATION ISOLATION SCHEDULE								
EQUIPMENT	HP	MOUNTING	ON GRADE			ABOVE GRADE		
			BASE TYPE	ASHRAE TYPE	ISOLATOR DEFLECTION	BASE TYPE	ASHRAE TYPE	ISOLATOR DEFLECTION
AIR COOLED CHILLERS		GRADE	A	4	1.0" (25)			
PUMPS	<40 HP		A	4	0.75" (19)			

HVAC LEGEND					
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	HOT WATER SUPPLY		UNION		BUTTERFLY VALVE
	HOT WATER RETURN		STRAINER		GATE VALVE
	CHILLED WATER SUPPLY		STRAINER WITH BLOW OFF		ANGLE VALVE
	CHILLED WATER RETURN		THERMOMETER		GLOBE VALVE
	SUCTION DIFFUSER WITH STRAINER		CIRCUIT SETTER		CONTROL VALVE, THREE WAY
	PUMP SYMBOL		PRESSURE INDICATOR		CONTROL VALVE, TWO WAY
	CONCENTRIC REDUCER		TRIPLE DUTY VALVE		PRESSURE REDUCING VALVE
	ECCENTRIC REDUCER FLAT ON BOTTOM		BALANCING VALVE		AUTOMATIC FLOW CONTROL VALVE
	ECCENTRIC REDUCER FLAT ON TOP		AUTOMATIC AIR VALVE		CHECK VALVE
	ELBOW TURNED DOWN		MANUAL AIR VALVE WITH DICHARGE TUBE		NEEDLE VALVE
	ELBOW TURNED UP		TEE		END CAP
	TEE OUTLET UP		PLUG VALVE		BLIND FLANGED
	EXISTING PIPING TO REMAIN		BALL VALVE		FLOW METER STATION
	PIPING TO BE DEMOLISHED		TEE OUTLET DOWN		
	EXISTING PIPING BELOW GRADE		CONNECT TO EXISTING		

AIR COOLED CHILLER SCHEDULE															
EQUIPMENT TAG	TONS	REFRIGERANT	EER	IPLV	WATER				ELECTRICAL			MFG	MODEL	NOTES	
					WPD (FT)	EWI	LWT	GPM	MCA (A)	MOCP (A)	VOLTAGE				Phase
ACC-1	90	R410A	9.3	13.3	10.70	55	45	200	182	200	460	3	Trane	CGAM090	

PUMP SCHEDULE											
EQUIPMENT TAG	GPM	PUMP HEAD (FT)	Pump Efficiency	HP	MOTOR		Voltage	Phase	MANUFACTURER	MODEL	REMARKS
					RPM	TYPE					
P-3	210	75	75.20%	7.5	1800	COOP	460 V	3	Bell & Gossett	SERIES 1510 - 2 BD	
P-4	210	75	75.20%	7.5	1800	COOP	460 V	3	Bell & Gossett	SERIES 1510 - 2 BD	

ABBREVIATIONS			
ACC#	Air Cooled Chiller - No.	MIN	Minimum
AC	Air Conditioning	MOD	Motor Operated Damper
AAV	Automatic Air Vent	MPT	Male Pipe Thread
ABV	Above	N/A	Not Applicable
AD	Access Door	NC	Normally Closed
ADP	Apparatus Dew Point	NIC	Not in Contract
AFF	Above Finished Floor	NO	Normally Open
BFP	Backflow Preventer	NPSH	Net Positive Suction Head
BHP	Brake Horsepower	NPT	National Pipe Thread
BMS	Building Management System	NTS	Not To Scale
BOP	Bottom of Pipe	PD	Pressure Drop
CHWR	Chilled Water Return	PI	Pressure Indicator
CHWS	Chilled Water Supply	POC	Point of Connection
CO	Clean Out	PRV	Pressure Reducing Valve
COL	Column Line	PS	Pressure Switch
DB	Dry Bulb Temperature	PSI	Pounds Per Square Inch
DP	Dew Point	PSIA	Pounds Per Square Inch Absolute
EAT	Entering Air Temperature	PSIG	Pounds Per Square Inch Gauge
EDB	Entering Air Dry Bulb	REG	Register
ELEC	Electric or Electrical	RH	Relative Humidity
ELEV	Elevation	SEER	Seasonal Energy Efficiency Ratio
EWB	Entering Air Wet Bulb	SHT	Sheet
EWT	Entering Water Temperature	SP	Static Pressure
FL	Floor	SPEC	Specifications
FOB	Flat On Bottom	SPL	Supply
FOT	Flat On Top	SS	Stainless Steel
FPT	Female Pipe Thread	STD	Standard
FT	Feet	T	Thermostat
FT HD	Feet of Head	T#	Tank - No.
FZ	Freezeout (low limit thermostat)	TDH	Total Dynamic Head
GAL	Gallons	TEMP	Temperature
GPD	Gallons Per Day	TOC	Top of Concrete
GPH	Gallons Per Hour	TOD	Top of Duct
GPM	Gallons Per Minute	TOP	Top of Pipe
HD	Head	TOS	Top of Steel
HP	Horsepower	TSTAT	Thermostat
HVAC	"Heating, Ventilating & Air Conditioning"	TYP	Typical
ID	Inside Diameter	VB	Vacuum Breaker
IE	Invert Elevation	VENT	Vent
LAT	Leaving Air Temperature	VFD	Variable Frequency Drive
LWB	Leaving Water Temperature	WB	Wet Bulb Temperature
LWT	Leaving Water Temperature	XFMR	Transformer
MAV	Manual Air Vent		
MAX	Maximum		
MBH	Thousand BTU/Hr (thousands)		

MECHANICAL GENERAL NOTES	
1.	DO NOT SCALE DRAWINGS. SEE ARCHITECTURAL DRAWINGS AND REFLECTED CEILING PLANS FOR EXACT LOCATIONS OF DOORS, WINDOWS, CEILING DIFFUSERS, ETC.
2.	USE ECCENTRIC REDUCERS ON AUTOMATIC VALVES WHERE REQUIRED.
3.	EXTEND ALL DRAIN LINES TO NEAREST FLOOR DRAIN OR AS INDICATED. ROUTE TO AVOID INTERFERENCE WITH PASSAGEWAYS. CONDENSATE DRAINS SHALL BE TRAPPED. SLOPE DRAIN LINES 1/8" PER FOOT.
4.	ALL PIPING SHALL PITCH DOWN IN DIRECTION OF FLOW OR AS INDICATED ON DRAWINGS. 1" PER 40 FEET WITH MANUAL AIR VENTS AT ALL HIGH POINTS. AND 3/4" DRAIN VALVES AT ALL LOW POINTS. ALL PIPING AND DUCTWORK INSULATION SHALL BE RUN CONTINUOUSLY THROUGH FLOORS, ROOFS AND PARTITIONS EXCEPT WHERE PROHIBITED BY FIRE CODES.
5.	EXTEND DRAIN LINES FROM RELIEF VALVES TO 2" ABOVE NEAREST FLOOR DRAIN OR AS INDICATED.
6.	ALL PIPING SHALL BE SUPPORTED IN ACCORDANCE WITH THE SPECIFICATIONS AND FURTHER SUPPORTS ON HANGERS SHALL BE ADJACENT TO ELBOWS, TO PREVENT WEIGHT OF PIPING BEING PLACED ON THE EQUIPMENT. SUPPORT DETAILS SHALL BE SUBMITTED TO THE MECHANICAL ENGINEER.
7.	ALL PIPING AND DUCTWORK LOCATIONS SHALL BE COORDINATED WITH THE WORK UNDER OTHER DIVISIONS OF THE SPECIFICATIONS TO AVOID INTERFERENCE.
8.	CORRECT SETTINGS ON ALL BALANCING FITTINGS SHALL BE PERMANENTLY MARKED.
9.	RUNOUTS SHALL PITCH DOWN IN DIRECTION OF FLOW A MINIMUM OF 1" IN 30 FEET.
10.	ALL PIPING, DUCTS, VENTS, ETC. EXTENDING THRU EXTERIOR WALLS AND ROOFS SHALL BE FLASHED AND COUNTERFLASHED. COORDINATE ORIENTATION OF SUPPLY AND RETURN PIPING BEFORE FABRICATION.
11.	PROVIDE DIELECTRIC FITTINGS AT ALL LOCATIONS WHERE DISSIMILAR METALS ARE JOINED IN PIPING AND DUCT SYSTEMS.

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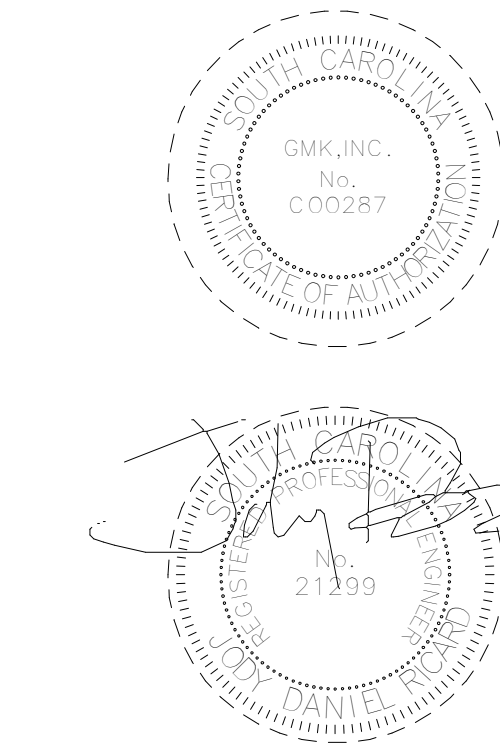
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MIDLANDS TECHNICAL COLLEGE - BELTLINE CAMPUS

project name
BSC BUILDING CHILLER REPLACEMENT H59-N071-FW

issued for
20074.01

seals/signature

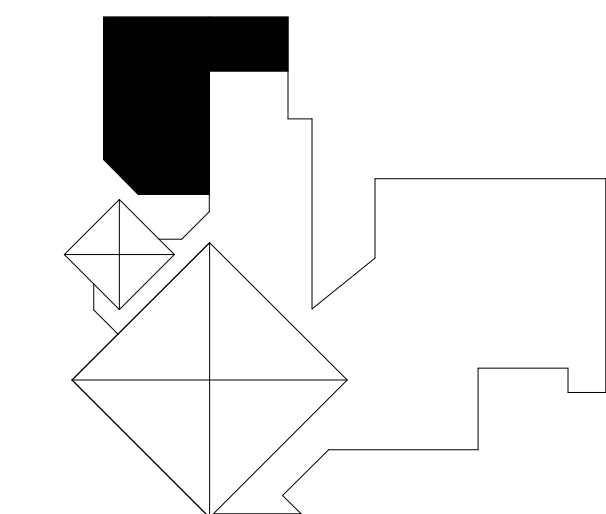


issued for
CONSTRUCTION

date
MAY 3, 2021

number	item	date
1	Addendum No. 3	06/10/2021

key plan



Key Plan

sheet title
HVAC LEGENDS, NOTES, ABBREVIATIONS, AND SCHEDULES

sheet number

M0.1

drawn by Author
checked by Checker