

**CITY OF BURLINGTON
REQUEST FOR PROPOSALS**

200 Church Street HVAC System Replacement

Date of Issuance:	September 9, 2022
Issued by:	City of Burlington Department of Parks, Recreation & Waterfront
Site Visit:	September 29, 2022 9:00 AM Mandatory for HVAC Contractors
Questions Due:	October 5, 2022 12:00 PM
Answers Posted:	October 10, 2022 12:00 PM
Proposal Due Date:	October 14, 2022 12:00 PM
Point of Contact:	Kim Bleakley, Central Facilities Manager Parks, Recreation & Waterfront 645 Pine Street, Burlington, Vermont 05401 802-557-7082 kbleakley@burlingtonvt.gov

I. INTRODUCTION

The City of Burlington is soliciting competitive proposals to replace the heating, ventilation and air conditioning (HVAC) system at 200 Church Street. This building was built in 1975 and is approximately 13,500SF. There are three occupied levels, two of which hold office space, and a basement level housing a full time server room for Burlington Telecom. Contractor will work directly with City Central Facilities Manager to coordinate installation. Throughout the construction, be advised that coordination will be required to work around potential impacts to current operations, in particular when work calls for any HVAC or electrical service interruption, or access to tenant controlled space. Interim HVAC measures may be required to provide environmental controls to all three levels, especially for extended periods of down time.

The City of Burlington will acquire and pay for building permit. Trade permits by contractor. All permits, including building permit, must be closed by contractor before time of final payment. Parking is the responsibility of the contractor.

II. SCOPE OF WORK

In an effort to improve the operating efficiency and comfort of the building occupants, the City will be replacing the existing operational HVAC system. The replacement system has been professionally specified and designed by LN. Consulting. Specifications and drawings are available as exhibits A and B in this RFP.

Successful project completion will include removal of existing system, through startup of new system including controls and permit closure. The City is open to completion timeline based on most efficient methods of installation and competitive pricing.

Specific Care for Building Interior during Construction:

Basement Server Area, First and Second Floors

All efforts must be taken by the contractor or subcontractor to eliminate or reduce the amount of airborne particulate (dust and related building materials) generated from construction related work activities on all floors. Controls could include tooling attachments, which provide a water delivery system or local exhaust ventilation. Furthermore, no dry sweeping of any construction related debris could occur. Sweeping compound must be used during all clean up to reduce the level of airborne particulate.

The testing and balancing controls contractor should be testing the system after installation to determine proper flow and capture. You might also ask that the subcontractor provide a dust control plan so you know exactly what efforts are made to keep the dust and debris level down.

Additional Care Note for Basement Server Area

The Contractor is responsible for damages, which would include down time costs should the Contractor cause equipment failure or equipment damage because of their negligence.

III. RESPONSE FORMAT

Bidders are encouraged to be concise. All proposals must include, and are limited, to the following:

1. All documents shall be in .pdf format.
2. Proposed scope of work. Responses should provide a straightforward and concise description of the respondent's capabilities to satisfy the requirements of this request.
3. Completed contractor proposal form and signature by authorized representative for the firm or company.
4. A description of your firm's history and experience with providing similar construction work, and a work history of up to three (3) related projects showing for each:
 - a. Name, address and phone number for each client.

- b. Brief project description.
5. Location of the office from which the management of the project will take place.
6. Signed and notarized Livable Wage, Outsourcing Ordinance and Union Deterrence Certifications.
7. Certificate of Insurance with City named as Additional Insured indicating coverage limits as required.

IV. CONTRACTOR SELECTION

A. Criteria: Proposals shall be evaluated based on the criteria listed below:

1. Priority assigned to the project and current workload of the firm with particular reference to the personnel and other resources being proposed (Note: Capacity to complete work in an efficient timeframe will be critical);
2. Past performance record and relevant experience;
3. Approach to project to complete in timeline;
4. Quality of work, timeliness and experience; and
5. Financial responsibility of the firm.*

Each General Contractor shall respond to evaluation criteria items 1 through 5 in a concise and easily identifiable manner. Information shall be utilized in the final selection decision.

*The firm must agree to carry professional liability insurance including errors and omissions in an amount not less than \$1,000,000. (See additional insurance requirements in Exhibit E: Burlington Standard Contract Conditions.)

B. Evaluation Criteria Assigned Weight:

1. Total Project Cost 40%
2. Qualifications 40%
3. Schedule 20%

TOTAL WEIGHT 100%

Proposals will be reviewed and evaluated by City staff based on the information provided. Additional information may be requested prior to final selection.

C. Rejection of Proposals: The City reserves the right to reject any or all proposals, to negotiate with one or more parties, or to award the contract in the City's best interests, including proposed contractor's schedule. The City reserves the right to re-advertise for additional proposals and to extend the deadline for submission of the proposals.

No proposal will be considered accepted until all necessary City authorizations, including those required by Board of Finance and City Council if necessary, have been received and an agreement is executed by both parties.

V. SUBMISSIONS

A. Deadline for Receipt of Proposals: All proposals in response to this Request for Proposals (RFP) must be received by the point of contact no later than 12:00 p.m. on the above due date. The proposal shall be marked "200 Church Street HVAC". Late proposals will not be accepted under any circumstances. Electronic proposals are preferred as long as they are received by the point of contact by the required deadline. It is the responsibility of the entity submitting replies and proposals to ensure that the point of contact has received a completed proposal by the required deadline.

B. Answers to Questions and Revisions to Request for Proposal: Any revisions, addendums and answers to questions received by the question deadline will be sent to consultants who directly received this proposal via email. In addition, revisions will be posted on the City's RFP web page <http://burlingtonvt.gov/RFP/>. It is advised that consultants sign up for the GovDelivery notification so that they will be notified of any changes to the RFP page.

Point of Contact:

Kim Bleakley,

Central Facilities Manager

Department of Parks, Recreation & Waterfront

kbleakley@burlingtonvt.gov

802.557.7982

VI. EXHIBITS

- A. Exhibit A: Specifications by L.N. Consulting
- B. Exhibit B: Drawings by L.N. Consulting
- C. Exhibit C: Contractor Proposal Form
- D. Exhibit D: Draft Contract ****For Your Preliminary Review****
- E. Exhibit E: Burlington Standard Contract Conditions
- F. Exhibit F: Burlington Livable Wage Certification
- G. Exhibit G: Burlington Outsourcing Ordinance Certification
- H. Exhibit H: Burlington Union Deterrence Ordinance Certification

Bid documents include this main body of the request for proposals and all exhibits.

VII. CONTRACTING

The contractor must qualify as an independent contractor and, prior to being awarded a contract, must apply for registration with the Vermont Secretary of State's Office to do business in the State of Vermont, if not already so registered. The registration form may be obtained from the Vermont Secretary of State, 128 State Street, Montpelier, VT 05633-1101, PH: 802-828-2363, Toll-free: 800-439-8683; Vermont Relay Service – 711; web site: <https://www.sec.state.vt.us/>. The contract will not be executed until the consultant is registered with the Secretary of State's Office.

Prior to beginning any work, the contractor shall obtain Insurance Coverage in accordance with the Burlington Contract Conditions (Exhibit E in this RFP). The certificate of insurance coverage shall be documented on forms acceptable to the City. In addition, the contractor shall obtain insurance to cover Champlain Broadband LLC DBA Burlington Telecom as specified in the Burlington Contract Conditions (Exhibit E in this RFP).

VIII. AGREEMENT REQUIREMENTS

The selected consultant will be required to execute a contract with the City on the terms and conditions required by the City, including but not limited to those in the Burlington Contract Conditions (Exhibit E) and the attached Draft Agreement. No proposal will be considered accepted until all necessary City authorizations—including those required by Board of Finance and City Council if necessary—have been received and an agreement is executed by both parties.

IX. LIMITATIONS OF LIABILITY

The City assumes no responsibility or liability for the response to this Request for Proposals.

X. COSTS ASSOCIATED WITH PROPOSAL

Any costs incurred by any person or entity in preparing, submitting, or presenting a proposal are the sole responsibility of that person or entity, including any requests for additional information or

interviews. The City will not reimburse any person or entity for any costs incurred prior to the issuance of the contract.

XI. INDEMNIFICATION

Any party responding to this Request for Proposals is acting in an independent capacity and not as an officer or employee of the City. Any party responding to this Request for Proposals will be required to indemnify, defend, and hold harmless the City, its officers, and employees from all liability and any claims, suits, expenses, losses, judgments, and damages arising as a result of the responding party's acts and/or omissions in or related to the response.

XII. REJECTION OF PROPOSALS

The City reserves the right to reject any or all proposals, to negotiate with one or more parties, or to award the contract to the proposal the City deems will meet its best interests, even if that proposal is not the lowest bid. The City reserves the right to re-advertise for additional proposals and to extend the deadline for submission of the proposals. This Request for Proposals in no way obligates the City to award a contract.

XIII. OWNERSHIP OF DOCUMENTS

Any materials submitted to the City in response to this Request for Proposals shall become the property of the City unless another arrangement is made by written agreement between the City and the responding party. The responding party may retain copies of the original documents.

XIV. DUTY TO INFORM CITY OF BID DOCUMENT ERRORS

If a bidder knows, suspects, or has reasonable cause to believe, that an error or omission exists in any bid documents, including but not limited to unit prices and rate calculations, the bidder shall immediately give the City written notice thereof. Contractor shall not cause or permit any work to be conducted that may related to the error or omission without first receiving written acknowledgment from the City that City representatives understand the possible error or omission and have approved the requested modifications to the bid or contract documents or that the contractor may proceed without any modification being made to the bid or contract documents.

XV. PUBLIC RECORDS

Any and all records submitted to the City, whether electronic, paper, or otherwise recorded, are subject to the Vermont Public Records Act. The determination of how those records must be handled is solely within the purview of City. All records the responding party considers to be trade secrets, as that term is defined by subsection 317(c)(9) of the Vermont Public Records Act, or that the responding party otherwise seeks to have the City consider as exempt must be identified clearly and specifically at the time of submission. It is not sufficient to merely state generally that a proposal is proprietary, contains a trade secret, or is otherwise exempt. Particular records, pages, and sections which are believed to be exempt must be specifically identified as such and must be separated from other records with a convincing explanation and rationale sufficient to justify each exemption from release consistent with Section 317 of Title 1 of the Vermont Statutes Annotated.

XVI. PUBLIC HEALTH EMERGENCIES

Bidders are advised that public health emergencies, as declared by the City, the State of Vermont, or the Federal Government, including the current pandemic of Novel Coronavirus (COVID-19)

Exhibit A

TABLE OF CONTENTS**DIVISION 22 - PLUMBING**

220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
220553	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
220719	PLUMBING PIPING INSULATION
221008	SANITARY WASTE AND VENT PIPING

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

230500	MECHANICAL GENERAL PROVISIONS
230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
230713	DUCT INSULATION
230719	HVAC PIPING INSULATION
232300	REFRIGERANT PIPING
233100	HVAC DUCTS AND CASINGS
233300	AIR DUCT ACCESSORIES
233700	AIR OUTLETS AND INLETS
236213	PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS
237200	AIR-TO-AIR ENERGY RECOVERY EQUIPMENT
238129	VARIABLE REFRIGERANT FLOW HVAC SYSTEMS
238216	AIR COILS

DIVISION 25 - INTEGRATED AUTOMATION

250000	HVAC INSTRUMENTATION AND CONTROLS
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DIVISION 26 - ELECTRICAL

260500	ELECTRICAL GENERAL PROVISIONS
260505	ELECTRICAL DEMOLITION
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533.13	CONDUIT
260533.16	BOXES
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
262715	ELECTRICAL CABINETS AND ENCLOSURES
262816.13	ENCLOSED CIRCUIT BREAKERS
262816.16	ENCLOSED SWITCHES

may introduce significant uncertainty into the project, including disruption of timelines or revised practices. Contractors shall consider public health emergencies as they develop project schedules and advance the work.

The City may require a public health emergency plan be submitted as part of the bid. This plan will contain:

- 1) Measures to manage risk and ensure that potential impacts to safety and mobility are mitigated in accordance with health and safety standards and guidelines proposed by local, state, and federal agencies (see attached Draft Contract, Sections 15 and Exhibit D;
- 2) A schedule for possible updates to the plan in advance of the start of work (see attached Draft Contract, Section 15); and
- 3) Means to adjust the schedule and sequence of work should the emergency change in nature or duration.

The City will have sole discretion to approve, deny, or require changes to this plan as a condition of consideration of the bid, will retain the right to inspect all work to ensure compliance with health and safety standards, and may at any time require the contractor to stop work because of the emergency.

If a public health emergency is declared, the City will not be responsible for any delays related to the sequence of operations or any expenses or losses incurred as a result of any delays. Any delays related to public emergencies, including the current pandemic of Novel Coronavirus (COVID-19), will be excusable, but will not be compensable.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other plumbing work.

1.2 RELATED REQUIREMENTS

- A. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- F. MSS SP-69-2003 - Pipe Hangers and Supports - Selection and Application.
- G. MSS SP-89-2003 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- H. MSS SP-90-2000 - Guidelines on Terminology for Pipe Hangers and Supports.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 PERFORMANCE REQUIREMENTS

- A. Design piping and equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Delegated Design: Design Metal Channel (Strut) Framing Systems, metal fabrications, trapeze hangers (for pipe and ductwork), equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 10.
1. Design supports for multiple pipes, including pipe stands and equipment capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design all components of supports for roof mounted equipment and ductwork to withstand wind and snow loads.
 4. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 22 piping and equipment supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.

1.6 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for the following:
1. Pipe hangers and supports.
 2. Post-installed concrete and masonry anchors.
 3. Non-penetrating rooftop supports.
 4. Metal framing systems.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; Include Product Data for components:

1. Trapeze hangers.
 2. Metal framing systems.
 3. Equipment supports.
 4. Application of protective inserts and shields at pipe hangers for each type of insulation and hanger.
- D. Delegated-Design Submittal: For trapeze hangers, roof mounted equipment, and pipes indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design calculations and detail for fabrication and assembly of trapeze hangers, metal framing systems, equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping. Show methods of attachment to building structure.
 2. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 22 piping and equipment supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.
- 1.7 QUALITY ASSURANCE
- A. Comply with applicable building code.
 - B. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
 - C. Reference "Plumbing General Provisions" in Division 22 for additional Quality Assurance requirements.

PART 2 PRODUCTS

- 2.1 SUPPORT AND ATTACHMENT COMPONENTS
- A. General Requirements.
 - B. Comply with MSS SP-58, Types 1 through 58, factory-fabricated components. If type of hanger or support for a particular situation is not indicated in this Section, select appropriate type using MSS SP-58 recommendations. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
 - C. Comply with MSS SP-69, including for pipe hanger selections and applications that are not specified in piping system Sections.
 - D. Comply with MSS SP-89.
 - E. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

- F. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
- G. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Anvil International, Inc.
 - 3. B-Line Systems, Inc.; a division of Cooper Industries (Eaton).
 - 4. Elite Components
 - 5. Empire Industries, Inc.
 - 6. ERICO/Michigan Hanger Co.
 - 7. Globe Pipe Hanger Products, Inc.
 - 8. GS Metals Corp.
 - 9. National Pipe Hanger Corporation (NPHC) (Not slides larger than NPS 4.)
 - 10. PHD Manufacturing, Inc.
 - 11. PHS Industries, Inc.
 - 12. Piping Technology & Products, Inc.
 - 13. The Pipe Supports Group (including Bergen-Power Pipe Supports and Carpenter & Paterson, Inc)
 - 14. Tolco Inc.
 - 15. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Galvanized, Metallic Coatings: Hot-dip galvanized according to ASTM A153 or ASTM A123. Required of all pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing except products specified to be painted or furnished in stainless steel.
- C. Where pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing are exposed to view by the building occupants: (1) in indoor finished spaces normally accessible by occupants, and (2) where specifically noted on the plumbing

drawings that aesthetics are a concern, they are to be finished as follows, in lieu of hot-dip galvanized:

1. Prime coat the related structural steel framing.
 2. Pipe support steel components (clevis, roller, guides, etc.) with plain finish or galvanized will be acceptable.
 3. Finish paint the pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing per Division 9 Section "Painting."
 4. Finish paint color for these items to be selected by project architect and approved by the owner.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable Clevis Hanger (MSS Type 1): For suspension of stationary pipes, NPS 1/2 to NPS 30. These hangers are permitted only where no movement is expected.
 2. Single Pipe Roll (MSS Type 41): For support of pipes, NPS 3/4 to NPS 30, from two (2) threaded rods if longitudinal movement caused by expansion and contraction might occur.
 3. Adjustable Steel Yoke Pipe Roll (MSS Type 43): For suspension of insulated pipe sizes NPS 2 1/2 to NPS 24, from one (1) threaded rod if longitudinal movement caused by expansion and contraction might occur.
 4. Complete Pipe Roll (Roller chair, MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary. Use only where specifically noted on drawings. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."
 5. Adjustable Roller Stand with Base Plate (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if longitudinal movement caused by expansion and contraction might occur. Provide with steel or cast iron base plate. Except where noted otherwise on the plumbing drawings, these roller stands are required wherever support is from a steel frame beneath the pipe. Weld base plate to frame. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."
 6. Pad eyes. For suspension of stationary pipes, NPS 1/2 to NPS 30 where there is inadequate room for another hanger type. Use only where specifically noted on drawings. Otherwise, use requires advance written approval by engineer.
 7. Concrete Rod Attachment Plate. For suspension of pipes, NPS 1/2 to NPS 30 where specifically noted on drawings. Utilize PHD Manufacturing, Inc. Figure 903, or equal, in

Type 316 stainless steel material. HDG carbon steel material will not be permitted.
Typical applications are as follows:

- a. Where condition of concrete is not suitable for anticipated point load of threaded rod.
 - b. Where threaded rod size required by this Section is larger diameter than the specified Type 316 stainless steel mechanical expansion anchor available sizes (historically not available above ¾" diameter.)
8. Adjustable Pipe Saddle Support (MSS Type 38): For support of pipes, NPS 2 to NPS 36, with carbon steel saddle and nipple with special cast iron reducing coupling. Provide with optional carbon steel base stand to support horizontal pipe. Use only where specifically noted on drawings. These are occasionally used beneath heavy piping components, such as to directly support large expansion joints where minimal thermal movement is expected. Mount on concrete pier, concrete pad, or steel support.
9. Split Ring Hangers, such as MSS Type 12, will not be permitted. Use on an exception basis requires advance written approval by engineer.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 F piping installations. Use only where specifically noted on drawings. Otherwise, use requires advance written approval by engineer.
 3. Threaded Rods: For dry interior and temporary installations, use ASTM F1554, Grade 36, manufactured from ASTM A36 low carbon steel, standard threaded rods, hot-dip galvanized according to ASTM A153. Such low carbon steel threaded rods shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A276, Type 316 stainless steel threaded rods. Rod couplings shall match threaded rod material and finish.
 4. Nuts: For dry interior and temporary installations, use ASME B18.2.2, ASTM A563, Grade A, Heavy Hex, carbon steel nuts only on threaded rods, sizes 1½" and smaller, and hot-dip galvanized according to ASTM A153. ASTM A563 nuts shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A194, Grade 8M (Type 316 stainless steel) Heavy Hex nuts.
 5. Washers: For dry interior and temporary installations, use ASTM F 844, steel, flat washers, and hot-dip galvanized according to ASTM A153. ASTM F 844 washers shall

never be plain finish. For exterior, damp, and wet locations utilize Type 316 stainless steel washers.

- I. Structure Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Welded-Steel Brackets: For support of pipes from above or below. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- J. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
- K. Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields for pipe (MSS SP-58, Type 40): Use where insulation with vapor barrier is indicated for pipes NPS 4 and smaller and also for piping materials other than steel. Of length recommended in writing by manufacturer to prevent significant compression of the pipe insulation insulation. Shields shall span an arc of 180 degrees. Pipes NPS 2-1/2 and larger shall include 100 psi calcium silicate inserts meeting ASTM C-533 Type 1, C-585, C-795, E-84, Thermal Conductivity ('k') .40 @ 75° mean. Insert material shall be at least as long as protective shield. Protection Shields dimensions shall be not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick
 - b. NPS 4: 12 inches long and 0.06 inch thick
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 2. As an alternative to Protection Shields, Thermal-Hanger Support Shield Inserts as specified herein may be used: For supporting insulated pipe; with same insulation thickness as piping insulation.

- L. Spring Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 - M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
 - N. Use mechanical expansion anchors or adhesive anchors instead of building attachments where required in concrete construction.
- 2.3 Materials for Metal Fabricated Supports: Comply with Section 055000.
- A. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - 2. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 3. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 5. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - C. Comply with MFMA-4.
 - D. Channel Material:
 - 1. Indoor Dry Locations: Use galvanized steel.
 - 2. Outdoor and Damp or Wet Indoor Locations: Use stainless steel.
 - E. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - F. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- 2.4 TRAPEZE HANGERS
- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

- B. Metal Trapeze Hanger Installation for piping systems: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

2.5 THERMAL-HANGER & SUPPORT SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
 - 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- F. Thermal-Hanger & Support Shield Installation: Install in pipe hanger or shield for insulated piping.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. This article shall pertain to structural steel framing and supports necessary to support piping and equipment only to the extent there is not a Division 5 Section "Metal Fabrications" or notes on the structural drawings addressing same. If so, these shall supersede this article.
- B. All structural steel shall conform to the latest issue of the American Institute of Steel Construction specifications for the design, fabrication, and erection of structural steel for buildings (AISC-360) and Structural Welding Code – Steel (AWS D1.1.) Structural steel shall be hot-dip galvanized according to ASTM A123 (Coating Grade 100 – 3.94 mils minimum) except areas to receive field welds. Apply ZRC cold galvanizing compound to field weld areas. Refer also to structural drawings and specifications such as for requirements for column base plate anchor bolts.
- C. Material for Structural Steel Shapes, to include plates, bars, channels and angles shall be carbon steel conforming to ASTM A36.
- D. Material for Structural Steel Wide Flange Beam Shapes shall be carbon steel conforming to ASTM A992.
- E. Material for Hollow Structural Sections (HSS) shall be carbon steel, cold formed, rectangular, yield strength 46 ksi minimum, conforming to ASTM A500, Grade B.
- F. Structural Steel bolted connection shall conform to the following:
 - 1. Structural Bolts: ASTM A325, Type 1, heavy hex steel, hot-dip galvanized according to ASTM A153, Class C.
 - 2. Nuts: ASTM A563, heavy hex carbon-steel, hot-dip galvanized according to ASTM A153, Grade C. Retap nuts in accordance with ASTM A385.
 - 3. Washers: ASTM F436 hardened carbon-steel, hot-dip galvanized according to ASTM A153, Class C.
- G. Refer to structural drawings and specifications for fastening systems such as mechanical expansion anchors and adhesive anchors.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Secure fasteners according to manufacturer's recommended torque settings.
- H. Remove temporary supports.
- I. Metal Channel (Strut) Framing Systems: Install per the MFMA published "Guidelines for the use of Metal Framing, latest edition."

3.2 HANGER AND SUPPORT INSTALLATION

- A. Install hangers and supports complete with necessary inserts, bolts, threaded rods, nuts, washers, shims, and other accessories.
- B. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- C. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- D. For drain piping installed near the floor inside buildings, the piping shall be supported as follows:
 - 1. Preference is to support piping from above using a premanufactured Welded-Steel Bracket or similar, in accordance with this Division 22 Section, secured to wall.
 - 2. Alternatively, piping may be supported from the floor if using only stainless steel support products within three inches (3") of the floor.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Install structure attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- G. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 are not exceeded.
- I. Refer to specific plumbing piping Sections for hanger spacing maximum and threaded rod minimum size requirements.

- J. Secure slide base plates to steel frames provided for such purpose by welding.
- K. Contractor shall be responsible for coordination of structural steel frames and supports necessary to properly support piping hangers and supports.

3.3 EQUIPMENT SUPPORTS

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

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Support Adjustments: Adjust supports to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

- C. Coatings: All pipe supports and secondary steel that are hot-dip galvanized carbon steel - The galvanizing shall be ground back to a depth of one to four inches prior to welding. A high zinc dust paint shall be used for touch-up after installation in accordance with MIL-P-21035

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2015.

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Nameplates.

- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Pipe markers.
- K. Pumps: Nameplates.
- L. Relays: Tags.
- M. Small-sized Equipment: Tags.
- N. Tanks: Nameplates.
- O. Thermostats: Nameplates.
- P. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- Q. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.
 - 4. Plastic: Comply with ASTM D709.

2.3 TAGS

- A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Plumbing Valves: Green.
 - 4. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- F. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 220719

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 22 1116 - Domestic Water Piping: Placement of hangers and hanger inserts.
- C. Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment: Placement of hangers and hanger inserts.
- D. Section 22 1413 - Storm Drainage Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- F. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2015.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- H. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

- J. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.
- K. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2012.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
- M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- 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.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

- 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 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Johns Manville Corporation: www.jm.com/#sle.
 - 2. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 4. Manson Insulation: www.imanson.com.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. Heavy-density, one-piece insulation made from inorganic glass fibers bonded with a thermosetting resin.
 - 2. Materials to comply with ASTM C 547, Type I, Grade A, 850°F or ASTM C 547, Type IV, 1,000°F.
 - 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 4. Furnish with factory-applied ASJ jacket.
 - 5. Complete, integrated system to meet maximum 25/50 flame-spread/smoke-developed indexes per ASTM E84.
 - 6. Thermal Conductivity (k Values): 0.23 BTU-in/hr-sq.ft.-°F at 75 deg F per ASTM C335.
 - 7. Service Temperature Range not less than 0 to 850°F.
 - 8. Moisture Sorption after 96 hours @120°F, 95%RH, ASTM C1104.
 - a. Fiberglass products: <5% by weight.
 - 9. Water Vapor Transmission: Jacket water vapor permeance of 0.02 perms or less per ASTM E96.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Indoor Vapor Barrier Finish:
 - 1. Vinyl emulsion type acrylic, compatible with insulation, black color.
- G. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 JACKETS

A. PVC Plastic.

1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Johns Manville Corporation; Zeston 2000 Series White PVC: www.jm.com/#sle.
 - b. Proto Corp.; LoSmoke PVC Fitting Covers: www.protocorporation.com.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 20 mil.
 - e. Connections: Brush on welding adhesive.
 - f. Containing UV inhibitor.
3. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Finish each fitting, joint, and valve with one of the following depending on the application:
 - a. On systems in utility-type buildings and for systems on industrial-type projects, install glass cloth or 100% cotton canvas, as specified above, with vapor barrier mastic or coating over insulation to provide a protective barrier. This system is to also be used where PVC covers are indicated, but are not molded or otherwise commercially available, such as for valves and some joints.
 - b. On exterior systems and for heat traced systems install aluminum covers.
 - c. For other systems, install PVC covers.
- F. Inserts and Shields:
1. Application: Piping 1 inches diameter and larger.
 2. Furnish insulation shields with or without inserts for NPS 1 thru NPS 2 insulated pipe supports, because these smaller pipe sizes are unlikely to significantly compress the pipe insulation. Furnish calcium silicate inserts in addition to insulation shields for NPS 2-1/2 and larger insulated plumbing pipe supports. Furnish same thickness insert as adjacent insulation. Wood inserts will not be accepted.
 3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 4. Insert Location: Between support shield and piping and under the finish jacket.
 5. Insert Configuration: Insert material shall be at least as long as protective shield, and of same thickness and contour as adjoining insulation; may be factory fabricated.
 6. Insert Material: Hydrous calcium silicate insulation.
 7. Refer to also inserts and shields requirements in Division 23 Section "Hangers and Supports for Plumbing Piping and Equipment."
- G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.
- H. Insulated pipe exposed in kitchens, bathrooms, walkin coolers and freezers, and other sanitary finished spaces where regular cleaning of piping is required: Finish with PVC jacket and fitting covers.

3.03 SCHEDULES

A. Plumbing Systems:

Service	Size	Insulation Thickness	Insulation Type
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Condensate Drains

All Sizes

1/2"

Glass Fiber

END OF SECTION

SECTION 221008 - SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes air conditioning condensate drainage, soil and waste, sanitary drainage and vent, and corrosive waste piping inside the building and to locations indicated.
- B. This Division 22 Section shall apply in every respect to temporary piping shown on drawings. Temporary piping shall be removed and areas restored to pre-existing conditions after Commissioning of permanent piping systems, unless otherwise indicated on the drawings.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum design (working) pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 20-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 100 psig.

1.4 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping; 2020.
- B. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2012.
- C. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2012.
- D. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- E. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2008.
- F. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2017
- G. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2010.
- H. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).

- I. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- J. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2013.
- K. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- L. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- M. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

1.5 RELATED SECTIONS

- A. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment".

1.6 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For pipe, tube, fittings, and couplings. Provide manufacturers catalogue information.
- C. Firestopping materials.
- D. Shop Drawings: For drainage system, include plans, elevations, sections, and details.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- F. All submittals of Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- G. Project Record Documents: Field survey and document actual locations and sizes of sanitary waste and vent piping, corrosive waste and vent piping, transitions, pipe fittings, cleanouts, fixtures, etc. Record changes in pipe location and additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as Adobe PDF format record drawings. Refer to Division 22 Section "Plumbing General Provisions" and the Division 1 specifications for additional record drawing requirements.

1.7 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Reference Division 22 Section "Plumbing General Provisions" for additional Quality Assurance requirements.

- C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- D. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 3 years of experience.

1.8 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 PVC PIPE AND FITTINGS, BURIED WITHIN 5 FEET OF THE BUILDING

- A. Solid-Wall PVC Pipe: ASTM D 2665, Schedule 40, drain, waste, and vent.
 - 1. PVC Joints: Solvent welded, with ASTM D 2564 solvent cement, ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - 2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Charlotte Pipe and Foundry Company (Basis of Design)
 - b. North American Pipe
 - c. Spears Manufacturing Co.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.3 PVC PIPE AND FITTINGS, ABOVE GRADE

- A. Solid-Wall PVC Pipe: ASTM D 2665, Schedule 40, drain, waste, and vent.
 - 1. PVC Joints: Solvent welded, with ASTM D 2564 solvent cement, ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

SANITARY WASTE AND VENT PIPING

2. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Charlotte Pipe and Foundry Company (Basis of Design)
 - b. North American Pipe
 - c. Spears Manufacturing Co.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

PART 3 EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Site Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground, Soil, Waste, and Vent Piping, to include condensate from equipment, and Aboveground, Kitchen Grease Waste and Vent Piping: Use the following piping materials:
 1. NPS 3/4 and larger: Solid Wall PVC Piping, Schedule 40, with solvent welded joints.
 2. For fire resistance rated wall penetrations, penetrations through horizontal assemblies, etc. use firestopping with ratings determined by ASTM E814 or UL1479 for use with plastic piping.

3.3 PIPING INSTALLATION

- A. Refer to Division 33 Section "Sewer Pipe" for Project-site sanitary sewer piping.
- B. Refer to Division 22 Section "Plumbing General Provisions" for basic piping installation.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- E. Sleeve pipe passing through partitions, walls and floors. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing. Refer to Division 22 Section "Plumbing General Provisions" for additional sleeve and mechanical sleeve seal requirements.

- F. Firestopping: Install per requirements found in Division 22 Section "Plumbing General Provisions."
- G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- I. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 1/4" per 1'-0" to the extent possible. Otherwise, 1/8" per 1'-0" may be acceptable where necessary; confirm with plumbing engineer via RFI before installing any piping at 1/8" per 1'-0". Confirm site tie-in invert elevation requirements with civil engineer prior to installation.
 - 2. Horizontal Sanitary Drainage Piping: 1/4" per 1'-0" to the extent possible. Otherwise, 1/8" per 1'-0" may be acceptable where necessary; confirm with plumbing engineer via RFI before installing any piping at 1/8" per 1'-0". Confirm site tie-in invert elevation requirements with civil engineer prior to installation.
 - 3. Vent Piping: 1/4" per 1'-0" to the extent possible. Otherwise, 1/8" per 1'-0" may be acceptable where necessary; confirm with plumbing engineer via RFI before installing any piping at 1/8" per 1'-0".
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- K. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- L. Inserts:
 - 1. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for Steel or Malleable Concrete Inserts (MSS Type 18) requirements.
 - 2. Provide inserts for placement in concrete formwork.
 - 3. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

4. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
5. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
6. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

- M. Select system components with pressure rating equal to or greater than system design (working) pressure.
- N. Provide access where cleanouts and valves are not exposed. Coordinate size and location of access doors with Section 083113.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Plumbing General Provisions" for basic piping joint construction.
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Install pipe hanger and support devices in accordance with Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install in accordance with ASME B31.9, MSS SP-58, MSS SP-69, and MSS SP-89.
- D. Support vertical piping and tubing at base and at each floor. Piping 2" and smaller shall be installed with mid-story guides. Support riser piping independently of connected horizontal piping.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install supports for vertical cast-iron soil piping every 15 feet.

- G. Install hangers for horizontal PVC piping with maximum spacing of 4 feet.
- H. Install supports for vertical PVC piping with maximum spacing of 10 feet. For sizes 2 inch and under, a guide shall be installed between required vertical supports. Such guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe.
- I. Support piping and tubing not listed above according to MSS SP-69, manufacturer's written instructions, ASME B31.9, and plumbing code.
- J. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- K. Install supports for vertical steel piping every 15 feet.
- L. Place hangers within 12 inches of each horizontal elbow.
- M. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Piping Specialties."

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main or sanitary manhole.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent and corrosive waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 230500 - MECHANICAL GENERAL PROVISIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes Contract requirements and the following basic mechanical materials and methods to complement other Division 21 and 23 Sections.

1. Transition fittings.
2. Escutcheons.
3. Flexible connectors.
4. Sleeves
5. Mechanical sleeve seals.
6. Nonshrink grout for equipment and sleeve installations.
7. Field-fabricated metal and wood equipment supports.
8. Installation requirements common to equipment specification sections.
9. Mechanical demolition.
10. Cutting and patching.
11. Touchup painting and finishing.

- B. Pipe and pipe fitting materials are specified in Division 21 and 23 piping system Sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 - F. The use of the word "Provide": Whenever the word "Provide" is used in the specifications and/or on the drawings, it shall mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.
 - G. The use of the word "Piping": "Piping" shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.
 - H. The use of the word "Material": Whenever the word material is used in the specifications and/or on the drawings, it shall mean any "product", "equipment", "device", "assembly", or "item" required under the contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
 - I. The term "Mechanical Contractor", "HVAC Contractor", "Plumbing Contractor" or "Contractor" refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Mechanical, HVAC, and/or Plumbing drawings and in the Mechanical, HVAC, and/or Plumbing Specifications.
 - J. The term "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. "accessible ceiling" indicates acoustical tile type hung ceilings. Concealed spline or sheetrock ceilings with access panes shall not be considered accessible ceilings.
 - K. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. NP: Nylon plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.
 - L. The following are industry abbreviations for rubber materials:
 - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 2. EPDM: Ethylene propylene diene terpolymer rubber.
- 1.4 CODES, STANDARDS, REFERENCES, AND PERMITS
- A. All material and workmanship shall comply with all the currently adopted editions of all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.

- B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.
- D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials, installation, and testing unless a more stringent requirement is noted elsewhere.

1.5 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Sleeves
 - 4. Mechanical sleeve seals.
 - 5. Escutcheons.
- C. Welding certificates.
- D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - 4. Equipment and accessory service connections and support details.
 - 5. Exterior wall and foundation penetrations.
 - 6. Fire-rated wall and floor penetrations.

7. Sizes and location of required concrete pads and bases.
 8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
- E. Prior to the purchasing of materials or the start of work, prepare a $\frac{1}{2}" = 1'-0"$ scale coordination drawing showing size, size and location of mechanical pipes, ducts, equipment, and appurtenances, relative to other trades. Distribute drawing to other trades, and Submit drawing to Design Professional for review and approval. No demolition or new work shall proceed until all trades have indicated their respective services on the coordination drawing, and the Engineer has reviewed and approved the coordination drawings. Coordination drawings shall not be utilized as the final as built drawings required in this specification.
- F. Coordination Drawings: For complete piping, air ducting, and controls systems installations with identification of seismic support systems.
- G. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- H. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.
- I. Whenever the Division 23 Sections require preparation of a delegated design submittal it shall be prepared within the contractor's scope of work using the services of a licensed and qualified professional engineer and the following shall pertain. Shop Drawings, and other submittals related to the Work, designed, or certified by such professional engineer, if prepared by others, shall bear such professional engineer's written approval when submitted. The professional engineer shall promptly inquire of the Engineer if the performance and design criteria are not clear and complete. The contractor is responsible for coordinating the work of the delegated design. The Engineer's review of all delegated design submittals shall be for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Engineer shall be entitled to rely upon, and shall not be responsible for, the adequacy and accuracy of the services, certifications, and approvals performed or provided by such professional engineers.
- J. Hydrostatic pressure piping test reports, each including a statement of pass/fail, and signed by the contractor.
- 1.6 QUALITY ASSURANCE
- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

- B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- D. Steel Pipe Welding and Copper Pipe Brazing: Given it is a requirement of ASME B31.9, qualify processes and operators according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.7 SYSTEM DESCRIPTION

- A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.8 SCOPE OF WORK

- A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Mechanical Drawings including materials and equipment required to create fully operational systems.
- B. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. In addition to all mechanical equipment, plumbing fixtures, and mechanical devices indicated on the Mechanical Plans, the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans and the Electrical Plans.
- C. The contractor shall be responsible for reviewing the Architectural, Electrical, and Fire Protection Plans. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Architectural, Electrical, Mechanical, and Fire Protection Plans regarding equipment locations, equipment quantities, piping and duct work routing, device locations, light locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for mechanical installation of all the equipment and devices shown on the Architectural Plans, Mechanical Plans, Plumbing Plans, Fire Protection Plans and the Electrical Plans regardless of whether they are indicated on the Mechanical Plans.

1.9 DRAWING INTERPRETATION

- A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturer's product. In the event of a field verification or coordination issue, report issue to Owner's construction supervisor.
- B. Piping and air duct plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The drawings do not necessarily indicate all required offsets, details and accessories and equipment to be connected or encountered in the way of new work.
- C. Generally, layout pipelines requiring drainage first, followed by large pipe mains, air duct and electrical conduit. Follow this procedure for an orderly installation but not to establish precedence of one trade over another. It must be understood that pipe and duct hanger installations must comply with seismic bracing requirements. Minimizing hanger lengths (structure to equipment and crossbars) to 12" and under minimizes the requirement for seismic bracing.
- D. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as well as to maintain clearances to equipment whether or not indicated on the drawings. The contractor shall provide all drains, traps and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.
- E. Do not install equipment, air ducting or piping in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.
- F. In some cases, drawings are based on products of one or several manufacturers, as listed on the contract documents. The contractor shall be held responsible for modifications made necessary by substitution of products or other manufacturers.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

- A. Refer to Division 1 Section "Facilities Services Coordination" for additional coordination required, to include meetings, field survey, and preparation and submittal of coordination drawings and schedules.
- B. Do not install any part of a system until all critical components of the systems and related systems have been approved. Coordinate individual parts of systems.
- C. Coordinate contract work with other work specified in other Sections. Relocate work if required for proper installation and functioning of other systems, at no extra cost to the Owner.
- D. Install products in accordance with manufacturer's instructions. Notify Design Professional if Contract Documents conflict with manufacturer's instructions. Comply with Design Professional's interpretations,
- E. In general, air duct, heating and sprinkler piping, and drainage lines take precedence over water, gas, and electrical conduits. The design professional will make final decisions regarding the arrangement of work which cannot be agreed upon by the contractors.

1.12 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.13 "AS-BUILT" RECORD DRAWINGS

- A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.
- B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.
- C. Formal As-built drawings shall be submitted for review at the completion of each phase of the work. The as-built drawings shall be 1/4" scale and created in electronic format utilizing current release of AUTOCAD. At the completion of each phase of work, the mechanical contractor shall submit to the Engineer the original field progress as-built drawings and the electronic files of the formal as-built drawings. Once these have been reviewed by the Engineer, print and furnish four sets of final as-built drawings to the Owner, plotted on 24" x 36" 'D' sized sheets. Final payment for the phase of work and the start of the next phase shall require acceptance of the as-built drawings.

1.14 GUARANTEE

- A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.
- B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.15 OPERATING AND MAINTENANCE MANUALS

- A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warranties.
- B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.
- C. Submit all data media in a detailed, organized, and complete manner. Provide electronic copy to Owners construction supervisor for engineer/architect review.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.

1. Metal, Flexible Connectors:
 - a. ANAMET Industrial, Inc.
 - b. Flexicraft Industries.
 - c. Mercer Rubber Co.
 - d. Uniflex, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. Rubber, Flexible Connectors:
 - a. General Rubber Corp.
 - b. Mercer Rubber Co.
 - c. Proco Products, Inc.
 - d. Uniflex, Inc.
 - e. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
3. Mechanical Sleeve Seals:
 - a. Metra Seals by Metraflex Co.
 - b. Link-Seal by Garlock Pipeline Technologies (GPT) ~ an Enpro Industries Company
 - c. Innerlynx by Advance Products & Systems, Inc.
 - d. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.2 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 21 and 23 piping Sections for pipe and pipe fitting materials and joining methods.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 and 23 piping Sections for joining materials not listed below.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping,

MECHANICAL GENERAL PROVISIONS

unless otherwise indicated. Given it is required by ASME B31.9, the brazing filler metal shall conform to an applicable AWS classification.

- C. No other copper or steel joint methods for piping, fittings, valves, or other piping system components (such as using grooved mechanical joints, associated mechanical couplings, or mechanical press seal joints) shall be permitted.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 3. Aboveground Pressure Piping: Pipe fitting.

2.5 SLEEVES

- A. The following materials are for wall, floor, slab, and roof penetrations:
- B. Galvanized-Steel Sheet: 0.0276-inch (24 gauge) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, galvanized, plain ends.
- D. Steel pipe sleeves for use with mechanical sleeve seals for underground building and structure exterior-wall and slab on grade pipe penetrations: ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, hot-dip galvanizing according to ASTM A123, plain ends. Continuously weld both sides of water stop plate, located to be at center of concrete wall or slab on grade, prior to hot-dip galvanizing.
- E. Steel pipe sleeves for use with mechanical sleeve seals for aboveground building and structure exterior-wall pipe penetrations: ASTM A 53, Type E, Grade B, Schedule 10 (minimum) pipe, hot-dip galvanizing according to ASTM A123, plain ends. Water stop plate not required.
- F. Cast Iron will Not be permitted: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- H. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- I. PVC Pipe: ASTM D 1785, Schedule 40.
- J. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 PIPING SPECIALTIES

- A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 - 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 - 2. OD: Completely cover opening.
 - 3. Cast Brass: Split casting, with concealed hinge and set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.

PART 3 EXECUTION

3.1 MECHANICAL DEMOLITION

- A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Demolish any existing associated wall sleeves except as noted below.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - 8. Whenever piping, ductwork, equipment, and appurtenances are indicated to be removed, resulting in a hole, opening, void, or other discontinuity in the adjacent architectural features, these features shall be infilled and restored to a continuous appearance and function as indicated or to match existing materials of construction. Waterproofing is to be repaired, where it existed before, or where indicated. If the resulting hole is indicated to be reused, any required wall sleeve shall be replaced unless in excellent condition.

- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- C. Disconnect, demolish, and remove Work specified in Division 21 and 23 Drawings and Sections.
- D. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- E. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- F. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- G. Removal: Remove indicated equipment from Project site.
- H. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 and 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.

- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following. For new piping use one-piece designs. For existing piping use split-casting designs. Additional escutcheon requirements for both new and existing piping follow:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: Deep-pattern type.
 - 2. Chrome-Plated Piping: Cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece stamped-steel type with spring clips for new piping. Split-plate, stamped-steel type with concealed hinge and spring clips for existing piping.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
 - 6. Bare Piping in Unfinished Service Spaces: Cast-brass type with polished chrome-plated finish.
 - 7. Bare Piping in Equipment Rooms: Cast-brass type.
 - 8. Bare Piping at Floor Penetrations in Equipment Rooms: Floor-plate type.
- M. Sleeve pipe passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. When installed as part of a UL-listed fire rated assembly, the sleeve shall meet the requirements of listing.
 - 2. Position pipe in center of sleeve.
 - 3. Cut sleeves to length for mounting flush with both surfaces. While not required by this Section, it is preferred that sleeves extend $\frac{1}{2}$ " beyond the wall on each side to the extent not conflicting with escutcheon installations.
 - a. Exception: For floors of mechanical equipment areas, parking garages, spaces that can anticipate washdown, and other wet areas extend sleeves 2 inches above finished floor level.
 - 4. Install sleeves in new walls and slabs as new walls and slabs are constructed. Securely fasten sleeves to the assemblies penetrated. Space outside sleeve perimeter is to be filled as follows.
 - a. Use grout for any portion installed thru existing concrete or CMU walls or concrete floors. Surface to be flush and continuous with existing wall and floor surfaces.
 - b. Use materials in compliance with UL-listed fire rated assembly and as required based upon adjacent materials of construction.
 - 5. Contractor to determine means and methods to install sleeves in existing walls and slabs. Coring concrete and masonry walls would be one possible method. Where multiple sleeves are required in a tight area, contractor may desire to remove a rectangular section of the wall or slab, and to then reconstruct the section with the sleeves, matching

existing materials and finishes. In that case, inquire with the architect and/or structural engineer via the RFI process and furnish a multi-trade coordinated and dimensioned sketch and intended approach to infill wall, to confirm each such location and approach is acceptable. Determination will be based, in part, if existing wall is load-bearing.

6. Install sleeves for interior wall and floor pipe penetrations that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Any pipe insulation is to be continuous through sleeve, unless not permissible where installed as part of a UL-listed fire rated assembly.
 - a. For interior wall and floor pipe penetrations, use the following sleeve materials:
 - 1) Steel Pipe Sleeves: For pipes smaller than NPS 6 and for all exposed floor pipe penetrations.
 - 2) Steel Sheet Sleeves: For pipes NPS 6 and larger, except exposed floor pipe penetrations. Where installed thru masonry or concrete wall, to be 12 ga (minimum,) with caution taken not to damage sleeve, especially when installing masonry, mortar, and grout. Steel pipe sleeves specified will be permitted.
 - 3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - b. For interior wall and floor pipe penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Use materials in compliance with UL-listed fire rated assembly where required. Refer to Division 7 Section "Joint Sealants" for materials and installation.
7. Permanent sleeves are not required in bare concrete walls for suitably sized core-drilled or formed holes with smooth concrete bore, unless a sleeve is required by UL-listed fire rated assembly. These holes may be formed by removable PE sleeves. Concrete walls that are part of a wall assembly (such as combined with insulation, brick, metal studs, gypsum wall board, etc.) require a sleeve extending thru the entire assembly.
8. Underground and aboveground, building and structure exterior-wall and slab on grade pipe penetrations: Seal penetrations using specified steel pipe sleeves and mechanical sleeve seals installed per manufacturer's written instructions. Select sleeve size in accordance with the Mechanical Sleeve Seal manufacturer's Engineering Manual. Generally, the annular clear space expected between the pipe OD and sleeve ID for installing mechanical sleeve seals as follows: For most pipes 6" and smaller expect annular space from approximately 9/16" to 1", and for most pipes 8" and larger expect annular space from approximately 1-5/8" to 2". Any pipe penetration thru foundation wall subject to plumbing code jurisdiction shall comply with International Plumbing Code requirement (305.3) for pipe sleeve to be two pipe sizes greater than the pipe passing through the wall. Install steel pipe sleeve with not greater than seven (7) degrees angular misalignment to pipe, preferably less.
 - a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material, design temperature, and size. Position pipe in center of

- sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
9. Underground, exterior-wall pipe penetrations: Where it is apparent that an opening in the wall was previously saw cut or otherwise created, opening created for installation of this work shall not be smaller than former opening in the same location.
10. For exterior wall installations both sleeve-to-wall and sleeve-to-pipe junctures shall be watertight.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Penetration Firestopping" for requirements.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.3 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements, applicable codes, manufacturer's instructions, and Division 21 and 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe that is to be butt welded.
- C. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before and after assembly. Remove all dirt, scale and other foreign matter from inside the pipe by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, equipment or fittings.
- E. Wherever tie-ins are made to existing steel piping, contractor shall first thoroughly clean end of existing pipe to remove dirt, scale, and other foreign matter from inside the pipe by use of a pipe swab or pipe "pig", and then shall measure pipe wall thickness. Corrosion allowance for all steel pipe Schedules on this project shall be 0.05" for sizes 1" and smaller, and 0.063" for pipes 1¼" and larger. Notify Design Engineer for direction where corrosion is in excess of this allowance. Connections to existing piping shall be in accordance with ASME B31.9, "Building Services Piping".
- F. Soldered Joints: Apply ASTM B 813, water-flushable lead-free flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 preparation and technique using

lead-free solder alloy complying with ASTM B 32. Lead-free shall mean a chemical composition equal to or less than 0.2 percent lead.

- G. Brazed Joints: Construct joints according to Copper Tube Handbook of the Copper Development Association, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- H. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or pipe-joint compound to male (external) pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- I. Welded Joints: Construct pipe joints according to AWS D1.1 or AWS D10.12 (select one for the project's pipe joints; contractor to determine and utilize the one that has the more stringent Welding Procedure Specifications - WPS's to be followed), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article. Given it is a requirement of ASME B31.9, the pipe joint WPS's shall be prepared and qualified according to ASME Boiler and Pressure Vessel Code (BPVC): Section IX, "Welding, Brazing and Fusing Qualifications."
- J. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use lubricant recommended by gasket manufacturer on bolt and cap screw threads, and underside of nuts and cap screw heads. Torque flange bolts as recommended in writing by gasket manufacturer.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 FIELD TESTING

- A. Prepare hydronic piping and steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush system with clean water. Clean strainers.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install a blank at flanged joints to isolate equipment. Blanks shall be of adequate thickness to prevent deformation under anticipated pressures, typically not less than 3/8" thick plate steel. Utilize equation in ASME B31.9 to calculate minimum required thickness of blank based upon allowable stress of blank material.
 5. Isolate piping outside scope of this work. Do not subject to test pressure.
 6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following examination and test on hydronic piping and steam and condensate piping:
1. ASME B31.9 mandates visual examination of all project pressure welds. These shall be performed by any trained and licensed journeyman or master pipefitter who is also a certified welder. The visual examination must be within the scope of his/her experience and he/she must be comfortable doing so.
 2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used. Pneumatic testing is discouraged due to safety risks and requires justification. Any pneumatic testing must be done in compliance with requirements of ASME B31.9. In service testing, without a hydrostatic pressure test, will only be permitted for the short sections of hydronic piping connecting to equipment and to existing piping. Owner will not be obliged to fund the replacement any existing valves not shown on the drawings to be replaced and that are found to leak during testing. Contractor is to carry cost for testing means that resolves any such concerns.
 3. Use vents installed at high points to release trapped air while filling system with water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design (working) pressure. Hydrostatic test pressure for ferrous and copper piping systems shall not be less than 150 psig. Review hydrostatic test pressure and methods for plastic piping systems with engineer in advance of testing; comply with manufacturer's test procedures. Test pressures shall not exceed maximum allowable pressure for any pipe, fitting, vessel, pump, valve, instrument, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength. Contractor is responsible for determining means and methods (to include necessary drains, vents, pipe anchors, etc.) to implement hydrostatic pressure tests, which are to include expansion joints to the extent feasible.

5. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic pressure test until there are no leaks.
6. Mechanical contractor shall determine location of testing caps and purge valves required for hydrostatic pressure testing.
7. Where expansion joints are installed at the time of test, the mechanical contractor shall bear all costs of preparing and submitting the design of any required temporary pipe restraints. Such a design shall be prepared by a professional engineer licensed in the state where the project is located.
8. Use low point drains and high point vents to completely remove liquid when testing is complete.

C. Prepare written report of hydrostatic pressure tests.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Equipment storage prior to installation.

1. All building interior equipment is to be stored indoors prior to installation, protected from weather, precipitation, and construction dust and damage, and in accordance with the manufacturer's installation instructions. Storage of such equipment outdoors during adverse weather (rain, snow, etc.) shall require manufacturer's advance written approval or the owner reserves the right to reject the equipment that in their reasonable opinion has been damaged by such storage and require the contractor to replace same with new at no additional expense to the owner.
2. All building exterior equipment may be stored outdoors if stored on dunnage in a high area with good drainage, and in accordance with the manufacturer's installation instructions. Piping connections and any other equipment openings shall be protected from the weather with caps, tarps, etc.
3. Stored equipment is to be covered with either the original packaging or an equivalent or better protective covering. Repair any damaged packaging. Cap the open ends of pipe connections. In areas where painting, plastering, spraying, and/or other dust generating activities have not been completed, all due precautions must be taken to avoid physical damage to the equipment and contamination by foreign material. Corrosive environments must be avoided. Store equipment in an upright position. Examine equipment before installing and remove any dirt or debris found in or on the equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

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

- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment to allow right of way for piping installed at required slope.
- F. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.7 PAINTING AND FINISHING

- A. Apply paint to exposed piping according to the following, unless otherwise indicated:
 - 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 - 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
- B. Do not paint piping specialties with factory-applied finish.
- C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Provide 2" chamfered edges on top of concrete pads. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete." Provide broom finish.
- B. The mechanical contractor shall fill each air handling unit fan inertia base with cast-in-place concrete. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.11 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.
- C. Mechanical Contractor shall be responsible for any patching of existing partitions after removal of duct work and HVAC piping.
- D. The Plumbing Contractor Shall be responsible for any patching of existing partitions after removal of plumbing piping.

3.12 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, anchors, and for sleeve installations where noted. Coordinate with requirements of structural drawings. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases and space around sleeves.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.

- G. Place grout around anchor plates.
- H. Cure placed grout according to manufacturer's written instructions.

3.13 FIRESTOPPING

- A. The trade contractor is responsible for providing proper U.L. Listed firestopping and smokestopping for all duct, pipe, controls conduit, and related electrical conduit installed by this trade contractor.
- B. The trade contractor shall utilize the latest fire and smoke protection materials and installation methods. The trade contractor shall guarantee that all materials installed are fire and smoke stopped per U.L. Listing, NFPA, building code requirements.
- C. The trade contractor shall utilize Architectural Life Safety Drawings to identify partition ratings. If the trade contractor is unsure of partition rating then he or she must inquire to Construction Manager.
- D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078410.
- E. Fire stopping shall be provided to both be compatible with the piping and meet the requirements of ASTM E 814 or ULC CAN-S115 , "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 230548 - Vibration and Seismic Controls for HVAC.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. MSS SP-58-2018 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation which includes Amendment 1 Issued 10-17-2019.
- F. MSS SP-69-2003 - Pipe Hangers and Supports - Selection and Application.
- G. MSS SP-89-2003 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- H. MSS SP-90-2000 - Guidelines on Terminology for Pipe Hangers and Supports.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 PERFORMANCE REQUIREMENTS

- A. Design piping and equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Delegated Design: Design Metal Channel (Strut) Framing Systems, metal fabrications, trapeze hangers (for pipe and ductwork), equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 10.
 1. Design supports for multiple pipes, including pipe stands, ductwork, and equipment capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design all components of supports for roof mounted equipment, piping, and ductwork to withstand wind and snow loads.
 4. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 23 piping, ductwork, and equipment supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.

1.6 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for the following:
 1. Pipe hangers and supports.
 2. Post-installed concrete and masonry anchors.

3. Nonpenetrating rooftop supports.
 4. Metal framing systems.
 - C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; Include Product Data for components:
 1. Trapeze hangers.
 2. Metal framing systems.
 3. Equipment supports.
 4. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
 - D. Delegated-Design Submittal: For trapeze hangers, roof mounted HVAC equipment, ducts, hydronic piping, and steam and condensate piping indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design calculations and detail for fabrication and assembly of trapeze hangers, metal framing systems, equipment supports, pipe stands, pipe anchors, pipe guides, and determining means of controlling thermal expansion of piping. Show methods of attachment to building structure.
 2. Contractor shall provide a stamped letter from a professional engineer licensed in the state where the project is located stating that all Division 23 piping and equipment supports, including anchors and fasteners, are designed and installed to carry the required loads at all substrates where located.
- 1.7 QUALITY ASSURANCE
- A. Comply with applicable building code.
 - B. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
 - C. Reference "Mechanical General Provisions" in Division 23 for additional Quality Assurance requirements.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements.
- B. Comply with MSS SP-58, Types 1 through 58, factory-fabricated components. If type of hanger or support for a particular situation is not indicated in this Section, select appropriate type

using MSS SP-58 and MSS SP-69 recommendations. Refer to MSS SP-58, Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

- C. Comply with MSS SP-69, including for pipe hanger selections and applications that are not specified in piping system Sections.
- D. Comply with MSS SP-89.
- E. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of HVAC work.
- F. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
- G. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. This article is to pertain also to copper piping that is scheduled to be uninsulated or to be insulated with other than flexible elastomeric cellular insulation (such as fiberglass insulation.)
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Anvil International, Inc.
 - 3. Advanced Thermal Systems, Inc. (Pipe slide assemblies only)
 - 4. B-Line Systems, Inc.; a division of Cooper Industries (Eaton).
 - 5. Elite Components
 - 6. Empire Industries, Inc.
 - 7. ERICO/Michigan Hanger Co.
 - 8. Globe Pipe Hanger Products, Inc.
 - 9. GS Metals Corp.
 - 10. National Pipe Hanger Corporation (NPHC) (Not slides larger than NPS 4.)
 - 11. PHD Manufacturing, Inc.
 - 12. PHS Industries, Inc.
 - 13. Piping Technology & Products, Inc.
 - 14. The Pipe Supports Group (including Bergen-Power Pipe Supports and Carpenter & Paterson, Inc)

15. Tolco Inc.
 16. Tri-State Industries, Inc. (Pipe slide assemblies only)
 17. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Galvanized, Metallic Coatings: Hot-dip galvanized according to ASTM A153 or ASTM A123. Required of all pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing except Steel Pipe-Covering Protection Saddles (MSS Type 39), pad eyes, and products specified to be painted or furnished in stainless steel.
- D. Where pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing are exposed to view by the building occupants: (1) in indoor finished spaces normally accessible by occupants, and (2) where specifically noted on the mechanical drawings that aesthetics are a concern, they are to be finished as follows, in lieu of hot-dip galvanized:
1. Prime coat the related structural steel framing.
 2. Pipe support steel components (clevis, roller, guides, etc.) with plain finish or galvanized will be acceptable.
 3. Finish paint the pipe hangers and support steel components (clevis, roller, guides, etc.) and related structural steel framing per Division 9 Section "Painting."
 4. Finish paint color for these items to be selected by project architect and approved by the owner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable Clevis Hanger (MSS Type 1): For suspension of stationary pipes, NPS 1/2 to NPS 30. These hangers are permitted only where no movement is expected.
 2. Single Pipe Roll (MSS Type 41): For support of pipes, NPS 3/4 to NPS 30, from two (2) threaded rods if longitudinal movement caused by expansion and contraction might occur.
 3. Adjustable Steel Yoke Pipe Roll (MSS Type 43): For suspension of insulated pipe sizes NPS 2 1/2 to NPS 24, from one (1) threaded rod if longitudinal movement caused by expansion and contraction might occur.
 4. Complete Pipe Roll (Roller chair, MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary. Use only where specifically noted on drawings. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."

5. Adjustable Roller Stand with Base Plate (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if longitudinal movement caused by expansion and contraction might occur. Provide with steel or cast iron base plate. Except where noted otherwise on the mechanical drawings, these roller stands are required wherever support is from a steel frame beneath the pipe. Weld base plate to frame. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."
6. Pipe Slide Assembly (MSS Type 35): For support of pipes, NPS 1 to NPS 24, if longitudinal and transverse movement caused by expansion and contraction might occur. Slide assembly consist of 25% glass filled, 3/32" thick PTFE slide bonded to hot-dip galvanized, minimum 1/4" thick carbon steel slide plate (or 1/2" thick graphite slide epoxy bonded and mechanically attached to hot-dip galvanized, minimum 1/4" thick carbon steel slide plate) which is factory welded to a hot-dip galvanized structural tee or "H". Field weld tee or "H" to pipe. Slide assembly also includes similar PTFE slide bonded to hot-dip galvanized, minimum 1/4" thick carbon steel base plate (or 1/2" thick graphite slide epoxy bonded and mechanically attached to hot-dip galvanized, minimum 1/4" thick carbon steel base plate) which is field secured to support frame by welding.
7. Except where noted otherwise on the mechanical drawings, utilize Anvil International Figure 257 Type 4 Pipe Slide Assembly, or equal, with structural tee and base plate for NPS 1 to NPS 4 and Figure 439 Type 4 Pipe Slide Assembly, or equal, with structural "H" and base plate for NPS 6 to NPS 24. Weld base plate to frame. Shim as required for vertical adjustment, and in compliance with Division 5 Section "Metal Fabrications."
8. Refer to Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for Spider Guides, Pipe Slide Guide Assemblies, and anchor materials.
9. Pad eyes. For suspension of stationary pipes, NPS 1/2 to NPS 30 where there is inadequate room for another hanger type. Use only where specifically noted on drawings. Otherwise, use requires advance written approval by engineer.
10. Concrete Rod Attachment Plate. For suspension of pipes, NPS 1/2 to NPS 30 where specifically noted on drawings. Utilize PHD Manufacturing, Inc. Figure 903, or equal, in Type 316 stainless steel material. HDG carbon steel material will not be permitted. Typical applications are as follows:
 - a. Where condition of concrete is not suitable for anticipated point load of threaded rod.
 - b. Where threaded rod size required by this Section is larger diameter than the specified Type 316 stainless steel mechanical expansion anchor available sizes (historically not available above 3/4" diameter.)
11. Adjustable Pipe Saddle Support (MSS Type 38): For support of pipes, NPS 2 to NPS 36, with carbon steel saddle and nipple with special cast iron reducing coupling. Provide with optional carbon steel base stand to support horizontal pipe. Use only where specifically noted on drawings. These are occasionally used beneath heavy piping components, such as to directly support large expansion joints or air separators where minimal thermal movement is expected. Mount on concrete pier, concrete pad, or steel support.

12. Split Ring Hangers, such as MSS Type 12, will not be permitted. Use on an exception basis requires advance written approval by engineer.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 F piping installations. Use only where specifically noted on drawings. Otherwise, use requires advance written approval by engineer.
 3. Threaded Rods: For dry interior and temporary installations, use ASTM F1554, Grade 36, manufactured from ASTM A36 low carbon steel, standard threaded rods, hot-dip galvanized according to ASTM A153. Such low carbon steel threaded rods shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A276, Type 316 stainless steel threaded rods. Continuous threaded rods are preferred. Rod couplings shall match threaded rod material and finish.
 4. Nuts: For dry interior and temporary installations, use ASME B18.2.2, ASTM A563, Grade A, Heavy Hex, carbon steel nuts only on threaded rods, sizes 1½" and smaller, and hot-dip galvanized according to ASTM A153. ASTM A563 nuts shall never be plain finish. For exterior, damp, and wet locations utilize ASTM A194, Grade 8M (Type 316 stainless steel) Heavy Hex nuts.
 5. Washers: For dry interior and temporary installations, use ASTM F 844, steel, flat washers, and hot-dip galvanized according to ASTM A153. ASTM F 844 washers shall never be plain finish. For exterior, damp, and wet locations utilize Type 316 stainless steel washers.
- I. Structure Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Welded-Steel Brackets: For support of pipes from above or below. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.

- J. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS SP-58, Type 39A or 39B): Use where insulation without vapor barrier is indicated. Use where insulation with vapor barrier is indicated for pipes NPS 5 and larger. Fill interior voids with insulation that matches adjoining insulation. Seal vapor barrier to ends and sides of saddles.
 2. Protection Shields for pipe (MSS SP-58, Type 40): Use where insulation with vapor barrier is indicated for pipes NPS 4 and smaller and also for piping materials other than steel. Of length recommended in writing by manufacturer to prevent significant compression of the pipe insulation insulation. Shields shall span an arc of 180 degrees. Pipes NPS 2-1/2 and larger shall include 100 psi calcium silicate inserts meeting ASTM C-533 Type 1, C-585, C-795, E-84, Thermal Conductivity ('k') .40 @ 75° mean. Insert material shall be at least as long as protective shield. Protection Shields dimensions shall be not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick
 - b. NPS 4: 12 inches long and 0.06 inch thick
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 3. As an alternative to Protection Shields, Thermal-Hanger Support Shield Inserts as specified herein may be used: For supporting insulated pipe; with same insulation thickness as piping insulation.
- L. Spring Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

- N. Use mechanical expansion anchors or adhesive anchors instead of building attachments where required in concrete construction.
- O. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.3 Materials for Metal Fabricated Supports: Comply with Section 055000.

- A. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - 2. Ferguson Enterprises Inc: www.fnw.com/#sle.
 - 3. Thomas & Betts Corporation: www.tnb.com/#sle.
 - 4. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - 5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - 6. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- C. Comply with MFMA-4.
- D. Channel Material:
 - 1. Indoor Dry Locations: Use galvanized steel.
 - 2. Outdoor and Damp or Wet Indoor Locations: Use stainless steel.
- E. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
- F. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

2.4 COPPER PIPE HANGERS AND SUPPORTS

- A. This article is to pertain only to copper piping that is scheduled to be insulated with flexible elastomeric cellular insulation.
- B. Copper piping that is to be insulated with flexible elastomeric cellular insulation, such as refrigerant piping, in horizontal, vertical, and inverted installations shall be supported from insulation clamps / clips providing the following required features to maintain continuous insulation of piping system:
 - 1. Support and secure the piping independent of the insulation.

2. Maintain continuous piping insulation and vapor barrier at insulation clamp.
3. The weight of the piping may not crush or tear the insulation over time.
4. UL Classified 2043 (25/50) for use in plenums and air handling systems.
5. ANSI/MSS SP-58 Type 61 Certified.
6. All metal components to have a Trivalent (non-hex) plating.
7. Selected for piping insulation wall thickness.
8. Molded with high strength Thermoplastic Olefin (TPO) with UV-Rated Additive.
9. Temperature rating: -60F to +225F.
10. Installed per insulation clamp manufacturer's installation instructions.
11. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Hydra-Zorb Co., Klo-Shure 7-Series, to be used with strut-mounted clamps in horizontal and inverted installations, sizes 1/4" to 4-1/8" O.D. (Basis of Design)
 - b. Hydra-Zorb Co., Titan Riser Clamps, to be used to support vertical riser installations, sizes 7/8" to 4-1/8" O.D. (Basis of Design)
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- C. Copper piping that is to be insulated with flexible elastomeric cellular insulation, such as refrigerant piping, to be supported from Metal Channel (Strut) Framing Systems.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Galvanized, Metallic Coatings: Hot-dip galvanized according to ASTM A153 or ASTM A123. Required of copper pipe related structural steel framing except products specified to be painted or furnished in stainless steel.
- F. Where pipe hangers and related structural steel framing are exposed to view by the building occupants: (1) in indoor finished spaces normally accessible by occupants, and (2) where specifically noted on the mechanical drawings that aesthetics are a concern, they are to be finished as follows, in lieu of hot-dip galvanized:
 1. Prime coat the related structural steel framing.
 2. Finish paint the related structural steel framing per Division 9 Section "Painting."
 3. Finish paint color for these items to be selected by project architect and approved by the owner.

- G. For copper piping hangers and supports use the following components, similar to those specified above for steel piping hangers and supports: Hanger-Rod Attachments, Structure Attachments, and Materials for Metal Fabricated Supports.
- H. Split Ring Hangers, such as MSS Type 12, will not be permitted. Use on an exception basis requires advance written approval by engineer.
- I. Use mechanical expansion anchors or adhesive anchors instead of building attachments where required in concrete construction.

2.5 TRAPEZE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- B. Metal Trapeze Hanger Installation for piping systems: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

2.6 THERMAL-HANGER & SUPPORT SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
 - 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

C. Insulation-Insert Material:

1. ASTM C-533 Type 1, calcium silicate meeting C-585, C-795, E-84, Thermal Conductivity ('k') .40 @ 75° mean.
2. ASTM C 552, Type II cellular glass may be an acceptable alternate.

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

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

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

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. This article shall pertain to structural steel framing and supports necessary to support piping and equipment only to the extent there is not a Division 5 Section "Metal Fabrications" or notes on the structural drawings addressing same. If so, these shall supersede this article.

B. All structural steel shall conform to the latest issue of the American Institute of Steel Construction specifications for the design, fabrication, and erection of structural steel for buildings (AISC-360) and Structural Welding Code – Steel (AWS D1.1.) Structural steel shall be hot-dip galvanized according to ASTM A123 (Coating Grade 100 – 3.94 mils minimum) except areas to receive field welds. Apply ZRC cold galvanizing compound to field weld areas. Refer also to structural drawings and specifications such as for requirements for column base plate anchor bolts.

C. Material for Structural Steel Shapes, to include plates, bars, channels and angles shall be carbon steel conforming to ASTM A36.

D. Material for Structural Steel Wide Flange Beam Shapes shall be carbon steel conforming to ASTM A992.

E. Material for Hollow Structural Sections (HSS) shall be carbon steel, cold formed, rectangular, yield strength 46 ksi minimum, conforming to ASTM A500, Grade B.

F. Structural Steel bolted connection shall conform to the following:

1. Structural Bolts: ASTM A325, Type 1, heavy hex steel, hot-dip galvanized according to ASTM A153, Class C.
2. Nuts: ASTM A563, heavy hex carbon-steel, hot-dip galvanized according to ASTM A153, Grade C. Retap nuts in accordance with ASTM A385.

3. Washers: ASTM F436 hardened carbon-steel, hot-dip galvanized according to ASTM A153, Class C.
 - G. Refer to structural drawings and specifications for fastening systems such as mechanical expansion anchors and adhesive anchors.
 - H. See Division 23 "Mechanical General Provisions" for grout.
- 2.9 Nonpenetrating Rooftop Supports for Low-Slope Roofs:
- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Anvil International; HBS Series (for piping \leq NPS2) (Basis of Design)
 2. Cooper B-Line, a division of Eaton Corporation
 3. Erico International Corporation, a brand of Pentair
 4. Ferguson Enterprises Inc
 5. Unistrut, a brand of Atkore International Inc
 6. Miro Industries, Inc.; 10-DS (for ductwork and piping), 6-H (for single pipes $>$ NPS 2) (Basis of Design). Comparable series to support equipment.
 7. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - B. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
 - C. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - D. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 - E. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
 - F. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Secure fasteners according to manufacturer's recommended torque settings.
- H. Remove temporary supports.
- I. Metal Channel (Strut) Framing Systems: Install per the MFMA published "Guidelines for the use of Metal Framing, latest edition."

3.2 HANGER AND SUPPORT INSTALLATION

- A. Install hangers and supports complete with necessary inserts, bolts, threaded rods, nuts, washers, shims, and other accessories.
- B. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- C. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- D. Install lateral bracing with pipe hangers and supports to prevent swaying.
- E. Install structure attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- F. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 are not exceeded. This is required for all projects.
- H. Hanger spacing maximum and threaded rod minimum size in the chart below shall be met.
Hanger Spacing and Rod Size for Straight Horizontal Runs
 - 1. NPS, in. Hanger Spacing, ft Rod Size, in.

	a. Hydronic,		Air,	
2.	1/2	7	8	3/8
3.	3/4	7	9	3/8
4.	1	7	9	3/8
5.	1-1/2	9	12	3/8
6.	2	10	13	3/8
7.	2-1/2	11	14	1/2
8.	3	12	15	1/2
9.	4	14	17	5/8
10.	5	14	17	5/8
11.	6	17	21	3/4
12.	8	19	24	3/4
13.	10	20	26	3/4
14.	12	23	30	7/8

15. Spacings above are for carbon steel pipe only and do not apply where concentrated loads are placed between supports such as flanges, valves, specialties, etc. Maximum spans in above table taken from ASME B31.1 table of suggested pipe support spacing. This table shall be a requirement that applies to all projects. Allows for a maximum sag of 0.1 inch between supports.

16. Refer to Division 23 piping Sections for hanger spacing and threaded rod size requirements for other than carbon steel pipe.

- I. Secure slide base plates to steel frames provided for such purpose by welding.
- J. Contractor shall be responsible for coordination of structural steel frames and supports necessary to properly support piping hangers and supports.
- K. Unless otherwise indicated on drawings or otherwise required by delegated design professional engineer, furnish specified Nonpenetrating Rooftop Supports for Low-Slope Roofs for support of roof mounted equipment, piping, and ductwork.

3.3 EQUIPMENT SUPPORTS

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

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Support Adjustments: Adjust supports to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. Coatings: All pipe supports and secondary steel that are hot-dip galvanized carbon steel - The galvanizing shall be ground back to a depth of one to four inches prior to welding. A high zinc dust paint shall be used for touch-up after installation in accordance with MIL-P-21035

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.
- E. Ceiling tacks.

1.2 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2015.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2016.

1.3 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.

- F. Ductwork: Nameplates.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Pipe markers.
- K. Pumps: Nameplates.
- L. Relays: Tags.
- M. Small-sized Equipment: Tags.
- N. Tanks: Nameplates.
- O. Thermostats: Nameplates.
- P. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- Q. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
 - 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.3 TAGS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.

2. Brady Corporation: www.bradycorp.com/#sle.
3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
4. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
5. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual Label.
- C. Color: Yellow/Black.

2.5 PIPE MARKERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Brady Corporation: www.bradycorp.com/#sle.
 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F. Color code as follows:
 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2. Toxic and Corrosive Fluids: Orange with black letters.
3. Compressed Air: Blue with white letters.

2.6 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 1. HVAC Equipment: Yellow.
 2. Fire Dampers and Smoke Dampers: Red.
 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Use tags on piping 3/4 inch diameter and smaller.
 1. Identify service, flow direction, and pressure.
 2. Install in clear view and align with axis of piping.
 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with self adhesive duct markers. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

- H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.

1.2 RELATED REQUIREMENTS

- A. Section 014000 - Quality Requirements: Employment of testing agency and payment for services.
- B. Section 23 3100 - HVAC Ducts and Casings.
- C. Section 25 0000 - HVAC Instrumentation and Controls

1.3 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems; 2015, Eighth Edition.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2002.

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 4. Include at least the following in the plan:

- a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
- b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
- c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
- d. Final test report forms to be used.
- e. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
- f. Expected problems and solutions, etc.
- g. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
- h. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
- i. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
- j. Confirmation of understanding of the outside air ventilation criteria under all conditions.
- k. Method of checking building static and exhaust fan and/or relief damper capacity.
- l. Time schedule for TAB work to be done in phases (by floor, etc.).
- m. Time schedule for deferred or seasonal TAB work, if specified.
- n. False loading of systems to complete TAB work, if specified.
- o. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.

- p. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - q. Procedures for formal progress reports, including scope and frequency.
 - r. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to the Construction Manager.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Progress Reports.
- G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit under provisions of Section 014000.
 - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in I-P (inch-pound) units only.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. SMACNA (TAB).
- B. Begin work after completion of each phase of each system. Systems to be tested, adjusted, or balanced and work completed prior to Substantial Completion of each phase and the project.

- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
 - D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
 - E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- 3.2 EXAMINATION
- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.

15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.

1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.

2. Discrepancies, deficient or uncompleted work by others.

3. Contract interpretation requests.

4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 FUME HOOD TESTING (ON SITE)

- A. General: Test fume hoods as installed to assess airflow velocity, airflow visualization, and level of containment. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.
- B. Preparation: Visit the project site to confirm that construction activities related to the fume hood system(s) and equipment are complete. Review design documents and Contractor's submittals. Verify that mechanical ventilation systems serving the space are functioning and operating in the normal mode. Notify Owner in writing, if conditions exist which preclude proper fume hood testing. Starting of testing constitutes acceptance of site conditions.
- C. Testing Requirements:
 - 1. Perform the following tests, in order:
 - a. Airflow Velocity Test.
 - b. Tracer Gas Containment Test.
 - 2. If more than one test procedure is selected, proceed to the next test only if any unsafe condition discovered during current test has been successfully rectified.
 - 3. Airflow Velocity Test: Comply with Section 9 of NEBB (FHT) Fume Hood Testing Standard - current edition.
 - 4. Tracer Gas Containment Test:

3.7 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Air system leakage testing shall be performed by either TAB contractor or mechanical contractor. Coordinate leakage requirements and testing requirements with 23 31 00 - HVAC Ducts and Casings.
- D. Measure air quantities at air inlets and outlets.

- E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
 - F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
 - G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
 - H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
 - I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
 - J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
 - K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
 - L. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
 - M. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
 - N. Commercial Kitchen Hoods; measure exhaust air flow for each Kitchen Hood at the various capacity stages noted on the controls drawings. Determine required air volumes and control system settings required to provide the proper exhaust air flows at design and part load conditions (as described on the controls drawings).
- 3.8 WATER SYSTEM PROCEDURE
- A. Adjust water systems to provide required or design quantities.
 - B. Provide balancing of all Heat Pump Loop system pumps for various percentages of design capacity as described in the Controls sequence of work. Measure and verify pump flow at each capacity step indicated.
 - C. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

- D. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- E. Effect system balance with automatic control valves fully open to heat transfer elements.
- F. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- G. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.9 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Plumbing Pumps.
 - 2. HVAC Pumps.
 - 3. Air Cooled Refrigerant Condensers.
 - 4. Air Coils.
 - 5. Terminal Heat Transfer Units.
 - 6. Air Handling Units.
 - 7. Fans.
 - 8. Air Inlets and Outlets.
 - 9. Energy Recovery Ventilators
 - 10. Variable Air Volume boxes

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
 - 7. Starter size, rating, heater elements.
 - 8. Sheave Make/Size/Bore.

B. V-Belt Drives:

1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.
6. Center to center distance, maximum, minimum, and actual.

C. Pumps:

1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Impeller.
5. Service.
6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

D. Air Cooled Condensers:

1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.

E. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Saturated suction temperature, design and actual.
11. Air pressure drop, design and actual.

F. Heating Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

G. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.

5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.
 8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.
 10. Inlet pressure.
 11. Discharge pressure.
 12. Sheave Make/Size/Bore.
 13. Number of Belts/Make/Size.
 14. Fan RPM.
- H. Return Air/Outside Air:
1. Identification/location.
 2. Design air flow.
 3. Actual air flow.
 4. Design return air flow.
 5. Actual return air flow.
 6. Design outside air flow.
 7. Actual outside air flow.
 8. Return air temperature.
 9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- I. Exhaust Fans:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.

6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- J. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
 10. Air correction factor.
- K. Duct Leak Tests:
1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.

9. Leakage.

L. Flow Measuring Stations:

1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

M. Terminal Unit Data:

1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

END OF SECTION

SECTION 230713 - DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Insulation jackets.

1.2 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 230553 - Identification for HVAC Piping and Equipment.
- C. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2015.
- D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
- E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- F. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.
- G. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2011.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
- I. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- 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 necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, FLEXIBLE

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Johns Manville: www.jm.com/#sle.
 - 2. Owens Corning Corporation: www.ocbuildingspec.com/#sle.

3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - B. Insulation: ASTM C553; flexible, noncombustible blanket.
 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Density: 1.5 lb/cu. ft.
 3. Maximum Service Temperature: 1200 degrees F.
 4. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - C. Vapor Barrier Jacket:
 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure sensitive tape.
 - D. Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
 - E. Outdoor Vapor Barrier Mastic:
 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- 2.3 GLASS FIBER, RIGID: INTERIOR APPLICATIONS
- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. Knauf Insulation: www.knaufusa.com.
 2. Johns Manville Corporation: www.jm.com.
 3. Owens Corning Corp: www.owenscorning.com.
 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 - B. Insulation: ASTM C612; rigid, noncombustible blanket.
 1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum service temperature: 450 degrees F.
 3. Maximum Water Vapor Sorption: 5.0 percent by weight.
 4. Minimum Density: 3.0 lb/cu ft.
 - C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:

1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.4 JACKETS

A. EPDM Jacket:

1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Carlisle SynTec Systems, Sure-Seal Kleen Non-reinforced EPDM Membrane (Basis of Design)
 - b. Firestone, RubberGard EcoWhite Platinum EPDM Membrane.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
2. EPDM Membrane (Exterior insulated duct) Jacket: ASTM D 4637, Type I, Class A, non-reinforced uniform, flexible EPDM sheet.
 - a. Thickness: 90 mils.
 - b. Exposed Face Color: White on black.
 - c. FM Approved.
 - d. 10 year material and labor warranty required.
 - e. Storage, handling, and installation to be per manufacturer's recommendations.

B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.

C. Aluminum Jacket: ASTM B209 (ASTM B209M).

1. Thickness: 0.016 inch sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch laps.

4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install in accordance with manufacturer's instructions.
- E. Install in accordance with NAIMA National Insulation Standards.
- F. Insulated Ducts Conveying Air Below Ambient Temperature:
 1. Provide insulation with vapor barrier jackets.
 2. Finish with tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- G. Insulated Ducts Conveying Air Above Ambient Temperature:
 1. Provide with or without standard vapor barrier jacket.
 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- H. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- I. Install multiple layers of insulation with longitudinal and end seams staggered.

- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- L. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with EPDM Membrane.
- M. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- N. Flexible Duct Wrap Insulation Installation: The contractor shall be responsible for damages resulting from loss of duct wrap R-value due to improper installation and/or over-compression of flexible duct wrap insulation system.
- O. Insulate residential kitchen exhaust and fume hood exhaust as per schedule below for exhaust air ductwork. Insulate the portion of dishwasher exhaust above the ceiling as per schedule below for exhaust air ductwork.

3.3 SCHEDULES

Service	Location	Size	Insulation Type	Minimum R-Value	Insulation Jacket
A.	Ductwork noted below with R-15 insulation may be insulated to R-12 minimum as per commercial building energy code.				
B.	Supply air systems indicated below to include outside air (OA) tagged ductwork where located downstream of an ERV.				
C.	Insulate Exhaust Air between ERV and Louver with Glass Fiber.				
D.	Insulate Outdoor Air between ERV and Louver with Glass Fiber.				

Round Supply Air Ductwork	Interior, Concealed and Exposed	All Sizes	Flexible Glass Fiber	R-8	Vapor Barrier Jacket
Rectangular Supply Air Ductwork	Interior, Concealed and Exposed	Smaller than 24"	Flexible Glass Fiber	R-8	Vapor Barrier Jacket
Rectangular Supply Air Ductwork	Interior, Concealed and Exposed	24" and Larger	Rigid Glass Fiber	R-8	Vapor Barrier Jacket
Rectangular Outdoor Air Ductwork	Exterior	All Sizes	Polyiso- cyanurate board	R-12	EPDM Membrane
Rectangular Exhaust Air Ductwork	Exterior	All Sizes	Polyiso- cyanurate board	R-12	EPDM Membrane

END OF SECTION

SECTION 230719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232300 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2015.
- H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2016.
- I. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- J. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010 (Reapproved 2016).

- K. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
- M. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- 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.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- 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

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.

1. Aeroflex USA, Inc; Aerocel SSPT: www.aeroflexusa.com/#sle (sub-paragraph B.2 below)
 2. Armacell LLC; AP Armaflex: www.armacell.us/#sle (sub-paragraph B.1 below)
 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle (sub-paragraph B.1 below)
 4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Comply with one of the following, in accordance with sub-paragraph D below:
1. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Type 1, Grade 1; use molded tubular material wherever possible.
 - a. Material: Closed-cell expanded rubber or NBR/PVC (Nitrile Butadiene Rubber) polymeric blend.
 - b. Minimum Service Temperature: -70 degrees F.
 - c. Maximum Continuous Service Temperature: 220 degrees F.
 - d. Thermal Conductivity (k Values): 0.245 (or 0.23) BTU-in/hr-sq.ft.-°F at 75°F per ASTM C 177 or C 518.
 - e. Connection: Waterproof vapor barrier adhesive.
 2. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Type 1, Grade 1; use molded tubular material wherever possible.
 - a. Material: Closed-cell EPDM-based rubber.
 - b. Minimum Service Temperature: -320 degrees F.
 - c. Maximum Continuous Service Temperature: 257 degrees F.
 - d. Thermal Conductivity (k Values): 0.245 BTU-in/hr-sq.ft.-°F at 75°F per ASTM C 177 or C 518.
 - e. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. The insulation product shall comply with the maximum service temperature of the VRF system. Coordinate maximum service temperature with manufacturer's product data of the selected system (based upon the approved VRF system submittal.) If any part of the insulated system may exceed 220 deg F service temperature, Aerocel SSPT by Aeroflex or comparable insulation (if accepted as a substitution) shall be furnished. Use only one insulation product for the entire VRF system. The insulation shall be installed to comply with the maximum service temperature of the VRF system. In any case, the insulation thicknesses scheduled below shall apply.
- E. Copper piping that is to be insulated with flexible elastomeric cellular insulation, such as refrigerant piping, in horizontal, vertical, and inverted installations to be supported from insulation clamps / clips as specified in Division 23 Section "Hangers and Supports for HVAC

Piping and Equipment" to maintain continuous insulation of piping system. Comply with manufacturer's installation instructions.

2.3 JACKETS

- A. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.024 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. For hot piping conveying fluids 110 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 110 degrees F, insulate flanges and unions at equipment.
- G. Inserts and Shields:
 - 1. Application: Piping 1 inches diameter and larger.
 - 2. Furnish insulation shields with or without inserts for NPS 1 thru NPS 2 insulated pipe supports, because these smaller pipe sizes are unlikely to significantly compress the pipe insulation. Furnish calcium silicate inserts in addition to insulation shields for NPS 2-1/2 thru NPS 4 insulated steel pipe supports and for NPS 2-1/2 and larger insulated non-steel

pipe supports. Furnish same thickness insert as adjacent insulation. Wood inserts will not be accepted.

3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Insert material shall be at least as long as protective shield, and of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: Hydrous calcium silicate insulation.
7. Refer to also inserts and shields requirements in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 078413.

I. Insulated pipe exposed in kitchens, bathrooms, walkin coolers and freezers, and other sanitary finished spaces where regular cleaning of piping is required: Finish with PVC jacket and fitting covers.

J. Exterior Applications: Provide vapor barrier jacket. Insulate fittings with insulation noted above. Insulate joints and valves with molded insulation of like material and thickness as adjoining pipe. Finish each fitting, joint, and valve with glass cloth or 100% cotton canvas with vapor barrier mastic or coating. Cover exterior pipe, fittings, joints, and valves with aluminum jacket, locate seams on bottom side of horizontal piping. Provide two coats of UV resistant finish for exterior flexible elastomeric cellular insulation without jacketing.

3.3 SCHEDULE

A. Heating and cooling systems.

Service	Size	Minimum Thickness	Insulation Type
Refrigerant Piping (Low Pressure)	All Sizes	1"	Flexible Elastomeric Cellular Insulation
Refrigerant Piping (High Pressure)	All Sizes	1"	Flexible Elastomeric Cellular Insulation
Refrigerant Piping (Liquid)	All Sizes	1"	Flexible Elastomeric Cellular Insulation

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END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Filter-driers.
- H. Solenoid valves.
- I. Expansion valves.
- J. Receivers.
- K. Flexible connections.

1.2 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 083113 - Access Doors and Frames.
- C. Section 230716 - HVAC Equipment Insulation.
- D. Section 230719 - HVAC PIPING INSULATION.
- E. Section 260583 - EQUIPMENT WIRING: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.
- B. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.
- C. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants; 2007.
- D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.
- E. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2013.

- F. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.
- G. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- I. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2013.
- J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2016.
- K. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- L. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.
- N. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- O. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- P. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
- D. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

1.5 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of Metal Channel (Strut) Framing Systems, trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Submit welders certification of compliance with ASME BPVC-IX.
- H. Project Record Documents: Field survey and document actual locations and sizes of refrigerant equipment, piping, transitions, pipe fittings, valves, refrigeration accessories, etc. Record changes in pipe location and additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as Adobe PDF format record drawings. Refer to Division 23 Section "Mechanical General Provisions" and the Division 1 specifications for additional record drawing requirements.
- I. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.6 QUALITY ASSURANCE

- A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.5 for installation of piping system.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 PIPING

- A. Copper Tube: ASTM B 280, ACR drawn temper (hard).
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.
- B. Pipe Supports and Anchors:
 - 1. Conform to ASME B31.5.
 - 2. Copper refrigerant piping in horizontal, vertical, and inverted installations to be supported from insulation clamps / clips as specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" to maintain continuous insulation of piping system. Comply with manufacturer's installation instructions.
 - 3. Refrigerant piping to be supported from Metal Channel (Strut) Framing Systems as indicated in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
 - 4. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 5. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 - 6. Rooftop Supports for Low-Slope Roofs: Except where detail provided otherwise, provide steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

2.2 REFRIGERANT

- A. Refrigerant: R-410A as defined in ASHRAE Std 34.

REFRIGERANT PIPING

2.3 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.4 VALVES

- A. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Packed Angle Valves:
 - 1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Ball Valves:
 - 1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.
- D. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.5 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.6 CHECK VALVES

- A. Globe Type:
 - 1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.
- B. Straight Through Type:

1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.7 FILTER-DRIERS

- A. Performance:
 1. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 2. Design Working Pressure: 350 psi, minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
- C. Construction: UL listed.
 1. Connections: As specified for applicable pipe type.

2.8 SOLENOID VALVES

- A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.
- B. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.9 ELECTRONIC EXPANSION VALVES

- A. Valve:
 1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
- B. Evaporation Control System:
 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
- C. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.10 RECEIVERS

- A. Internal Diameter 6 inch and Smaller:

1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- B. Internal Diameter Over 6 inch:
 1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.
- 2.11 FLEXIBLE CONNECTORS
 - A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
 1. Install in accordance with ASME B31.5.
 2. Support horizontal piping as indicated.
 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.

- 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Provide copper plated hangers and supports for copper piping.
 - G. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
 - H. Provide clearance for installation of insulation and access to valves and fittings.
 - I. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 083113.
 - J. Flood piping system with nitrogen when brazing.
 - K. Insulate piping and equipment; refer to Section and Section 230716.
 - L. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
 - M. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
 - N. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
 - O. Fully charge completed system with refrigerant after testing.
 - P. Provide electrical connection to solenoid valves. Refer to Section 260583.
- 3.3 FIELD QUALITY CONTROL
- A. See Section 014000 - Quality Requirements, for additional requirements.
 - B. Test refrigeration system in accordance with ASME B31.5.
 - C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.
- 3.4 SCHEDULES
- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.

7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Nonmetal ductwork.
- C. Casings and plenums.
- D. Kitchen hood ductwork.
- E. Cleaning of new duct installations.

1.2 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 230593 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 230713 - Duct Insulation: External insulation and duct liner.
- D. Section 233300 - Air Duct Accessories.
- E. Section 233600 - Air Terminal Units.
- F. Section 233700 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2017.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2016.
- F. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2015.

- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
- H. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
- I. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2015.
- J. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
- K. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2016.
- L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- M. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2015.
- N. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.
- O. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
- P. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.
- Q. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012, 2nd Edition.
- R. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.
- S. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.
- T. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for all pressure class systems.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
- E. Project Record Documents: Field survey and document actual locations and sizes of air moving equipment, ducts, duct fittings, air duct accessories, air outlets and inlets, etc. Record changes

in fitting location and type. Show additional fittings used. Record drawings are to be contractor-prepared by modifying the source digital files (typically AutoCAD and/or Revit to be furnished by the Design Engineer.) Submit both the modified digital files as well as Adobe PDF format record drawings. Refer to Division 23 Section "Mechanical General Provisions" and the Division 1 specifications for additional record drawing requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. All Ducts: Galvanized steel, unless otherwise indicated.
- C. AHU & Ventilation Supply: 4 inch w.g. pressure class, galvanized steel.
- D. Ventilation Air Return: 4 inch w.g. pressure class, galvanized steel.
- E. Ventilation Air Exhaust: 4 inch w.g. pressure class, galvanized steel.
- F. Ventilation Air Outdoor Air: 4 inch w.g. pressure class, galvanized steel.
- G. Terminal Unit Supply: 3 inch w.g. pressure class, galvanized steel.
- H. Terminal Unit Return: 3 inch w.g. pressure class, galvanized steel.
- I. General Exhaust: 4 inch w.g. pressure class, galvanized steel.
- J. Fan Coil Ductwork: 3 inch w.g. pressure class, galvanized steel.

- K. Residential Kitchen Hood Exhaust Ductwork: 2 inch w.g. pressure class, galvanized steel.
- L. Dishwasher Exhaust: 4 inch w.g. pressure class, stainless steel.
 - 1. Construct of 18 gauge, 0.0500 inch stainless steel using continuous external welded joints in rectangular sections.
- M. Grease Exhaust: 4 inch w.g. pressure class, stainless steel, Type 304. See also 2.4.C below for an acceptable (and generally preferred) factory built alternative.
 - 1. Construct of 18 gauge, 0.0500 inch stainless steel.
 - 2. Construction:
 - a. Liquid tight with continuous external weld for all seams and joints.
 - b. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
 - 3. Access Doors:
 - a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
 - b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.
 - 4. Field install two layers of 2" high temperature insulation blanket (wrap) in accordance with ASTM E2336-04, IBC, and NFPA 96.
- N. Fume Hood Exhaust: 4 inch w.g. pressure class, stainless steel.
- O. Outside Air Intake: 4 inch w.g. pressure class, galvanized steel.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
- B. Stainless Steel for Ducts: ASTM A666, Type 304.
- C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 4. For Use with Flexible Ducts: UL labeled.

- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 6. Other Types: As required.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
- C. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- D. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- G. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 2. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 3. Maximum Velocity: 4000 fpm.
 - 4. Temperature Range: Minus 10 degrees F to 160 degrees F.

- B. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 2. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 3. Maximum Velocity: 4000 fpm.
 - 4. Temperature Range: Minus 20 degrees F to 210 degrees F.
- C. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel, Type 409, or Type 304 stainless steel sheet outer jacket.
 - 1. Factory built, zero clearance to combustibles, suitable for Type I (Grease) and Type II (Heat and non-flammable vapors) kitchen ventilation hoods, NFPA 96 compliant.
 - 2. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 - 3. Certified for zero clearance to combustible material in accordance with:
 - a. UL 2221 with a 2 hour rating.
 - 4. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
 - a. UL 1978.
 - b. UL 2221.
 - c. UL 103HT, 6" - 14" diameters.
 - 5. Construction:
 - a. Liquid tight.
 - b. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
 - 6. Access Panel:
 - a. Refer to NFPA 96, section 7 for complete information. Requires provisions for the inspection of, and access for, cleaning of grease ducts. Openings are to be located on the top or side of the duct at changes or direction, to access and inspect fire suppression components within the duct, within 3 ft. of the inlet and outlet of any inline fan. Horizontal portions of ducts 20 inches by 20 inches or larger shall provide at least one opening for personnel entry. Smaller horizontal ducts shall provide openings large enough for cleaning at 12 ft. intervals.
 - b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.

7. Prepare and submit dimensioned fabrication drawings, bill of materials, details, and catalog component cutsheets, including supports.
 8. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Metal-Fab, Inc., Zero Clearance Model 3G Grease Duct System (Basis of Design)
 - b. AMPCO by Hart & Cooley, Inc; Z-Clear: www.ampcostacks.com/#sle.
 - c. DuraVent; DuraZDuct (DIS3Z): www.duravent.com/#sle.
 - d. Security Chimneys International; Secure Duct (CIX3Z): www.securitychimneys.com/#sle.
 - e. Selkirk Corporation; ZeroClear (IPS-Z3): www.selkirkcommercial.com/#sle.
 - f. Van-Packer Co.
 - g. CaptiveAire Systems
 - h. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- D. Dishwasher Exhaust: Minimum 18 gage, 0.05 inches thick, single wall, Type 304 stainless steel.
1. Field fabricated, single wall fully welded system. No flexible duct connections permitted.
 2. Fabricated and installed to be liquid tight preventing exhaust leakage into the building.
 3. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
- E. Fume Hood Exhaust: Minimum 21 gage, 0.0344 inch thick, single wall, Type 316 stainless steel.
1. Field fabricated, single wall fully welded system. No flexible duct connections permitted.
 2. Fabricated, and installed to be liquid tight preventing exhaust leakage into the building.
- 2.5 CASINGS and PLENUMS
- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

1. Provide clear wire glass observation ports, minimum 6 by 6 inch size.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge, 0.0598 inch sheet steel back facing and 22 gauge, 0.0299 inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber insulation media, on inverted channels of 16 gauge, 0.0598 inch sheet steel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts: Connect to metal ducts with adhesive.
- E. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- J. Use double nuts and lock washers on threaded rod supports.
- K. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- L. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- M. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
- N. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness, except where access panels are required.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Air Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Penetration Firestopping."

- O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."
- Q. Install Grease Exhaust system in accordance with manufacturer's written instructions and NFPA-96 requirements. Install with minimum slope required. Furnish access door(s) and low point drain(s.)

3.3 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Supply-Air Ducts: Seal Class A.
 - 3. Exhaust Ducts: Seal Class A.
 - 4. Return-Air Ducts: Seal Class A.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 6. Unconditioned Space, Exhaust Ducts: Seal Class A.
 - 7. Unconditioned Space, Return-Air Ducts: Seal Class A.
 - 8. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 9. Conditioned Space, Exhaust Ducts: Seal Class A.
 - 10. Conditioned Space, Return-Air Ducts: Seal Class A.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Leakage Tests:
 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 2. Test the following systems:
 - a. Supply Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
 - b. Return Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
 - c. Exhaust Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
 - d. Outdoor Air Ducts: Test 100 percent of the duct mains. Randomly test representative branch duct sections totaling no less than 50 percent of total installed branch ducts.
- B. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 3. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
 - a. Allowable Leakage, Supply Duct Systems: 1 percent of design airflow.
 - b. Allowable Leakage, Return Duct Systems: 2 percent of design airflow.
 - c. Allowable Leakage, Exhaust Supply Duct Systems: 2 percent of design airflow.

- d. Allowable Leakage, Supply Duct Systems, Terminals to Air Outlets: 2 percent of design airflow.
- 4. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
- 5. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.7 CLEANING OF NEW DUCT INSTALLATIONS

- A. Follow SMACNA's "Duct Cleanliness for New Construction Guidelines."
 - 1. At minimum new duct installation shall meet the Intermediate Level of Duct Cleanliness. While the Guidelines shall govern and is more detailed, in general Intermediate Level requires clean and dry storage and working areas, internal surfaces of duct wiped down to remove excess dust immediately prior to installation, and open ends of installed ductwork to be sealed nightly.
 - 2. Advanced Level of Duct Cleanliness shall be met for any LEED project and any area of a project where a cleanroom is desired (at minimum.) Advanced Level, in addition to the provisions for Intermediate Level, requires ductwork to be sealed during shipment and storage, and no internal labels. Again, the Guidelines shall govern and is more detailed.
 - 3. No excess dust or any debris shall be allowed to enter duct after wipe down. Construction Manager shall be responsible for verifying and enforcing these Guidelines.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Combination fire and smoke dampers.
- C. Duct access doors.
- D. Duct test holes.
- E. Fire dampers.
- F. Flexible duct connections.
- G. Smoke dampers.
- H. Volume control dampers.
- I. Birdscreen.

1.2 RELATED REQUIREMENTS

- A. Section 078413 - Penetration Firestopping.
- B. Section 230548 - Vibration and Seismic Controls for HVAC.
- C. Section 233100 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- B. NFPA 92 - Standard for Smoke Control Systems; 2015.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2014.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- G. UL 555C - Standard for Safety Ceiling Dampers; 2014.
- H. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- E. Project Record Drawings: Record actual locations of access doors and test holes.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- B. Provide factory sleeve and collar for each damper.
- C. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- D. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- E. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

- F. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.3 DUCT ACCESS DOORS

- A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
- B. Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.5 FIRE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- B. Ceiling (Radiation) Dampers: Galvanized steel, 22 gauge, 0.0299 inch frame and 16 gauge, 0.0598 inch flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
 - 1. Rated for three hour service in compliance with UL 555C.
- C. Horizontal Dampers: Galvanized steel, 22 gauge, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.
- E. Multiple Blade Dampers: 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- F. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.6 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.

- B. Flexible Duct Connections: Fabric crimped into 24 gauge galvanized steel edging strip.
 - 1. Indoor applications. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric. Minimum density 30 oz per sq yd. Meets NFPA 90A, 90B, and 701. UL 723 compliant. Suitable for kitchen exhaust. Airtight and waterproof at 10 in. w.g. to 10 in. negative w.g. Meet or exceed SMACNA steel requirements.
 - 2. Outdoor applications. Fabric: UL listed fire-retardant hypalon coated woven glass fiber fabric. Minimum density 24 oz per sq yd. Meets NFPA 90A, 90B, and 701. UL 723 compliant. Suitable for kitchen exhaust. Airtight and waterproof at 10 in. w.g. to 10 in. negative w.g. Meet or exceed SMACNA steel requirements. UV resistant.

2.7 SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.
- C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.8 ULTRA-LOW LEAKAGE MANUAL VOLUME DAMPERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - 1. Nailor Industries, Inc.
 - 2. Ruskin Company
 - 3. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. Provide SMACNA approved volume dampers
- C. Basis-of-Design Products: Subject to compliance with the requirements, provide Nailor Industries model 1090 round 4" to 24" manual volume dampers with accessory option model HLQ2 hand locking quadrant with 2" standoff bracket and Nailor Industries models 1110 (a single parallel blade, for ducts less than or equal to 9" high) and 1120 (opposed blade, for ducts greater than or equal to 10" high) rectangular manual volume dampers with accessory option model CDQUAD hand locking quadrant with HQ2 2" standoff bracket.
- D. Alternate products which may be acceptable, subject to compliance with the requirements: Ruskin CDRS25 (round balancing damper) and Ruskin CD60 (rectangular balancing damper). Ruskin CD40 Thinline would be required for rectangular balancing dampers less than 18" high since those have 4" wide blades.

- E. Products which do not meet this Ultra-Low Leakage Manual Volume Damper specification will be rejected. Based upon prior experience, these include:
 - 1. Nailor 1810/1820 rectangular manual volume dampers. These are not airfoil or low leakage design.
 - 2. Buckley 3300 takeoff damper. These are lighter duty, are not supplied with locking quadrant and standoff mounting bracket for insulated duct, and do not have blade and bearing seals.
 - F. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts. Provide double flange type frame for rectangular dampers 8" high and under. Do not use channel frame (which are set inside duct) for rectangular dampers 8" high and under.
 - G. Blades: Airfoil shape, 0.064-inch-thick, galvanized sheet steel.
 - H. Blade Seals: Vinyl.
 - I. Blade Axles: Round with seals at penetrations, galvanized steel.
 - J. Shaft: Round with seals at penetrations
 - K. Tie Bars and Brackets: Galvanized steel.
 - L. High quality hand locking quadrants. Include 2 inch standoff bracket for insulated ducts.
 - M. Self-lubricating bronze bearings.
 - N. Rectangular dampers shall be Ultra-low leakage, Class 1A (less than 8 cfm per square foot leakage at 4" w.g), per AMCA Standard 500-D-98.
 - O. Round dampers shall have less than 10 cfm per square foot leakage at 4" w.g., per AMCA Standard 500-D, Fig 5.5.
- 2.9 VOLUME CONTROL DAMPERS
- A. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
 - B. Single Blade Branch Volume Dampers: Fabricate for duct sizes up to 6 x 30 inch.

1. Fabricate for duct sizes up to 6 by 30 inch.
 2. Blade: 24 gauge, 0.0239 inch, minimum.
- C. Multi-Blade Branch Volume Dampers: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
1. Blade: 18 gauge, 0.0478 inch, minimum.
- D. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
- E. Control Dampers. Control dampers shall be as specified on the drawings and shall meet the following minimum construction standards. Refer to schedule on drawing M3.01 and controls drawing notes for responsibilities for furnishing and installing dampers and damper actuators.
1. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 - a. Ruskin Company
 - b. TSI, Inc.
 - c. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
 2. Flanged round damper fully manufactured of 316 stainless steel material with maximum 0.1 inch w.g pressure drop at specified air flow rate and electric actuator capable of 0 to 90 degree rotation in 1.5 seconds. Damper shall be TSI Inc. model EL-316-FLA-S/S or equal approved in writing by engineer.
 3. Industrial grade bubble tight dampers: Dampers shall be butterfly type consisting of oval blade, mounted to axle within formed flanged frame. Frame shall be constructed of steel channel with a clean and smooth interior surface. Blade shall be minimum 1/4 inch (6) thick and be complete with full circumference silicone blade seal mechanically attached to blade with full circumference retainer ring. Adhesive seals are not acceptable. Damper shaft shall be continuous solid steel extending through the entire damper diameter and extending beyond damper bearing a minimum of 6 inches. Stub type axles are not acceptable. The axle shall be supported in sealed, relubricable, ball bearings mounted outboard of frame and be complete with axle shaft seals. All parts not otherwise protected shall be given one coat of epoxy- polyamide coating. Dampers shall be designed and tested for bubbletight leakage performance at the specified design pressure. Each damper shall be individually tested for leakage in conformance to AMCA Standard 500-D-98; Section 8.2.3.2. Submittal data shall include pressure drop data developed from testing in accordance with AMCA Standard 500 in an AMCA registered laboratory. Damper shall be Ruskin model BTO92 or equal approved in writing by engineer.

4. Low temperature, foam-injected, thermally-isolated control dampers: Dampers frame shall be 5" x 1" x .125" minimum thickness 6063T6 extruded aluminum hat channel with hat mounting flanges on both sides of the frame. Each corner shall include two die formed internal braces that are machine staked for maximum rigidity. Blades shall be airfoil type extruded aluminum (maximum 6" depth) with thermal break located underneath tooled blade edge seal pocket. Damper blades to be provided with thermal protecting high density CFC foam. Blade edge seals shall be Santoprene type or equivalent mechanically locked into the blade edge. Adhesive or clip-on type seals are unacceptable. Jamb seals shall be polycarbonate compression type to prevent leakage between blade end and damper frame. Blade end overlapping frame is unacceptable. Multiple section dampers must have factory installed jackshafts unless clearly eliminated by engineer. Bearings shall be corrosion resistant, stainless steel. Axles shall be hexagonal shaped, positively locked into the damper blade. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure drop and noise generation. Temperature limits shall be -40°F to +165°F maximum. Submittal must include leakage, maximum air flow and maximum pressure ratings based on testing performance in accordance with AMCA std. 500D for Air Performance, Air Leakage and Thermal Efficiency. Maximum damper leakage shall not exceed 8 cfm/sq. ft. @ 4" w.g. (0.23cm/m² at 1 kPa). Thermal efficiency shall be no less than 300%. Damper shall be Ruskin model TED50XT or equal approved in writing by engineer.

F. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade manual volume dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.10 BIRDSCREEN

- A. Birdscreen: To be 304 Stainless Steel, 0.5" x 0.5" wire mesh, woven-intercrimp weave, 16 ga. wire, and 79% free area.
- B. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following.
 1. McNichols, Item 3805064810 (Basis of Design)
 2. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 233100 for duct construction and pressure class.

AIR DUCT ACCESSORIES

- B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- C. Provide duct test holes where indicated and required for testing and balancing purposes.
- D. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- H. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- I. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- J. Use splitter dampers only where indicated.
- K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- L. Provide birdscreen where indicated. Size to suite each opening. Furnish 304 stainless steel intermediate supports. Furnish with edging.

END OF SECTION

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers:
 - 1. Perforated ceiling diffusers.
- B. Rectangular ceiling diffusers.
- C. Round ceiling diffusers.
- D. Registers/grilles:
 - 1. Ceiling-mounted, exhaust and return register/grilles.
 - 2. Ceiling-mounted, supply register/grilles.
 - 3. Wall-mounted, supply register/grilles.
 - 4. Wall-mounted, exhaust and return register/grilles.
- E. Louvers:
- F. Roof hoods.
- G. Goosenecks.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012.
- B. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2015.
- C. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (R2011).
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

PART 2 PRODUCTS

2.1 Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, those that are scheduled on the drawings.

- A. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.2 ROUND CEILING DIFFUSERS

- A. Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Diffuser collar shall project not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
- B. Fabrication: Steel with baked enamel finish.
- C. Color: As selected by Architect from manufacturer's standard range.
- D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.3 RECTANGULAR CEILING DIFFUSERS

- A. Type: Square, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
- B. Frame: Inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel with baked enamel finish, except aluminum in laboratories.
- D. Color: As selected by Architect from manufacturer's standard range.

2.4 PERFORATED FACE CEILING DIFFUSERS

- A. Type: Perforated face with fully adjustable pattern and removable face.
- B. Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel with steel frame and baked enamel finish, except aluminum in laboratories.
- D. Color: As selected by Architect from manufacturer's standard range.

AIR OUTLETS AND INLETS

2.5 CEILING SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Aluminum extrusions with factory enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.

2.6 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish. Provide aluminum fabrication in laboratories.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.7 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.8 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: Steel frames and blades, with factory baked enamel finish.
- D. Color: To be selected by Architect from manufacturer's standard range.

2.9 LOUVERS

- A. Available manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, those that are scheduled on the drawings.
 - 1. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.
- B. Type: 6 inch deep with blades on 35 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake. Bird screen to comply with requirements in Division 23 Section "Air Duct Accessories".
- C. Color: To be selected by Architect from manufacturer's standard range.
- D. Fabrication: 0.125 inch thick extruded aluminum frame and 0.081" thick extruded aluminum blades, welded assembly, with Kynar finish.

2.10 GOOSENECKS

- A. Fabricate in accordance with 1 of minimum 18 gauge, 0.0598 inch galvanized steel.
- B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

2.11 DUCT MOUNTED EXHAUST GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Filter: Filter clips capable of accommodating 2" deep filter.
- C. Grille Attachment: Grill is attached to frame with full length piano hinge.
- D. Material: Formed Aluminum.
- E. Finish: Electrocoat acrylic baked enamel.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.12 DUCT MOUNTED SUPPLY DIFFUSER

- A. Type: Duct Diffuser, perforated holes with mitered, offset, aluminum frame for easy installation on a round, flat oval, or rectangular duct assembly or fitting body using sheet metal screws.
 - 1. Provide units with Integral Balance Damper.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

END OF SECTION

SECTION 236213 - PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Condensing unit package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Refrigerant piping connections.
- E. Motor starters.
- F. Electrical power connections.

1.2 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230548 - Vibration and Seismic Controls for HVAC: Placement of vibration isolators.
- C. Section 232300 - Refrigerant Piping.
- D. Section 237313 - Modular Indoor Central-Station Air-Handling Units.
- E. Section 23 8216 - Air Coils.
- F. Section 250000 - HVAC Instrumentation and Controls
- G. Section 260583 - EQUIPMENT WIRING: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.
- B. AHRI 365 I-P - Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units; 2009.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.
- D. ASHRAE Std 23.1 - Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; 2010.
- E. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Amendments and Errata.

- F. ASHRAE Std 90.2 - Energy-Efficient Design of Low-Rise Residential Buildings; 2007, Including All Addenda.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- H. NEMA MG 1 - Motors and Generators; 2016.
- I. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS

- A. See Mechanical Schedule Drawings

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Include equipment served by condensing units in submittal, or submit at same time, to ensure capacities are complementary.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling/heating coils, refrigerant piping, and accessories required for complete system.
- D. Design Data: Indicate pipe and equipment sizing.
- E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- F. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Lubricating Oil: One complete change.

1.6 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

- C. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- D. System Seasonal Energy Efficiency Ratio/Energy Efficiency Ratio (SEER/EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- E. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Unit shall be shipped with doors bolted shut to prevent damage during transport and thereafter while in storage awaiting installation.
- C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.
- D. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide a five year warranty to include coverage for refrigerant compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. AAON CFA: www.aaon.com (Basis of Design)
- B. Daikin/McQuay: www.daikinapplied.com
 - 1. Written guarantee is required indicating that the supply and exhaust/return fans can be operated by the Building Management System to modulate to maintain a duct static pressure set point for both the supply and return ducts (independently).
- C. Annexair: www.annexair.com
- D. Or equal. Packaged heat pump condensing unit and modular indoor air handling unit/energy recovery ventilation unit comprising of the complete refrigerant system shall be supplied from the same equipment manufacturer's representative. Exceptions to this requirement must be approved in writing by engineer. Refrigerant piping to be supplied by mechanical contractor with sizing confirmed by manufacturer.

E. Substitute equipment may be considered for approval that includes at a minimum:

1. R-410A refrigerant
2. Hinged access doors with lockable handles
3. Variable capacity compressor with 10-100% capacity
4. All other provisions of the specifications must be satisfactorily addressed
5. Modulating hot gas reheat

F. Petra, DSP Series. Petra Engineering Industries Co. www.petra-eng.com

G. Substitutions: See Section 016000 - Product Requirements.

2.2 MANUFACTURED UNITS

- A. Units: Self-contained, packaged, heat pump, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, wind deflector, and screens.
- B. Construction and Ratings: In accordance with AHRI 210/240. Test in accordance with ASHRAE Std 23.1.
- C. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 I-P and indicated in the schedule drawings.
- D. Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid and hot gas connection valves, and unit controls.
- E. Condensing unit shall include air-cooled condenser coils, condenser fans, discharge and liquid and hot gas connection valves, and unit controls.
- F. Unit shall be factory assembled and tested including leak testing of the coil(s) and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
- G. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- H. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
- I. Installation, Operation and Maintenance manual shall be supplied within the unit.
- J. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
- K. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

- L. Unit shall be completely factory assembled, piped, wired and shipped in one section.
- M. Unit shall be specifically designed for outdoor installation.
- N. Condenser coils shall be mechanically protected from physical damage by painted galvanized steel louvers (wire grille) covering the full area of the coil.
- O. Access to condenser coils, condenser fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles.
- P. Unit shall include a forkliftable base.
- Q. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

2.3 CASING

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish. Color to be selected by architect from manufacturer's standard options.
- B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.
- C. Provide removable access doors or panels with quick fasteners and piano hinges.
- D. All cabinet walls roof and floor shall be a high performance composite panel constructed with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core providing a rigid, impact resistant surface.
 - 1. The walls of the control compartment shall be 2 inches thick with a minimum R value of 12.5.
 - 2. The roof of 8 foot wide models shall be sloped at a minimum of ¼ inch per foot and shall be an average of 2.5 inches thick and an R value of 15.7.
 - 3. The floor of the control compartment shall be 3 inches thick with a minimum R value of 18.8. The floor shall also have an aluminum tread plate covering the appropriate equipment access areas.
 - 4. The access doors shall be 2 inches thick with a minimum R value of 12.5. All hinges shall be full-length and constructed of stainless steel. The perimeter cross section shall be stepped to allow an overlap of the panel wall and compression of a bulb type full perimeter gasket within the cabinet panel wall.
 - 5. The foam shall have a minimum density of 2 pounds per cubic feet.
 - 6. All foam material shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610 degrees F.

7. All panels shall have a thermal break with no metal path from inside to outside.
- E. Paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- F. A walk-in compartment (or reach-in department depending on unit size) shall contain the compressors and electrical control panel. The compartment shall be provided with an LED light fixture with a wire guard. The light shall be controlled by a wall switch and shall remain energized regardless of the position of the main power switch.
- G. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided in both point-to-point and ladder form.
- H. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
- I. Access to items needing periodic checking or maintenance shall be through hinged access doors with latches that have provisions for a padlock.
- J. Access doors shall have stainless steel hinges and full perimeter gasketing.
- K. Side service access doors shall have a rain gutter over the door.
- L. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.
- M. Unit shall include lifting lugs or shall be designed with forklift slots.

2.4 CONDENSER OPTIONS:

- A. Air Cooled/Heated Heat Pump Condenser Section:
 1. The condenser coils, facing out, shall be protected by a sheet of perforated metal.
 2. The condensing section shall be equipped vertical discharge axial flow direct drive 1170 RPM fans with all aluminum construction and adjustable blade pitch. Direct drive fans shall be directly connected to and supported by the motor shaft. Motor bearings have external lubrication connections.
 3. The condenser coils shall be sloped to protect the coils from damage.
 4. Condenser coils shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 5. Condenser coils to be sized for a minimum of 10°F of refrigerant sub-cooling.
 6. Condenser fans shall be high efficiency electronically commutated motor driven with factory installed head pressure control module. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F.

7. The mechanical refrigerant system shall be capable of operation down to an ambient of 2 deg F in heating mode.
8. Condenser coils shall be copper tubes with aluminum fins mechanically bonded to the tubes and with a baked-on phenolic corrosion resistant coating.
9. Coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5 year non-prorated warranty.

2.5 ELECTRICAL

- A. Unit shall be provided with standard power block for connecting power to the unit.
- B. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.

2.6 FANS AND MOTORS

- A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Equip with roller or ball bearings with grease fittings extended to outside of casing.
- B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection. Refer to Section 230513.
- C. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
- D. Fan motor shall be weather protected, single phase, direct drive, and open drip proof with inherent overload protection.

2.7 COMPRESSORS

- A. Compressors shall be scroll type tandem arrangement with internal thermal overload protection and mounted on the compressor manufacturer's recommended rubber vibration isolators. Each pair of tandem compressors shall have independent refrigerant circuits.
- B. Compressors shall be mounted in an isolated walk-in compartment to permit operation of the unit without affecting performance when the door to the compartment is open during routine maintenance or service.
- C. Compressors shall be isolated from the base pan to avoid any transmission of noise from the compressor into the support structure.
- D. Mounting: Statically and dynamically balance rotating parts and mount on spring vibration isolators.

- E. Sump Oil Heater: Evaporates refrigerant returning to sump during shut down. Energize heater continuously when compressor is not operating.
- F. Compressors shall be scroll type with thermal overload protection, (independently) (tandem) circuited, and carry a 5 year non-prorated warranty.
- G. Variable capacity compressor shall be capable of modeling capacity from 10-100%.
- H. Each compressor shall include a crankcase heater.

2.8 REFRIGERATION SYSTEM

- A. Compressors shall be R-410A scroll type with thermal overload protection, individually (tandem) circuited. Each compressor shall be furnished with a crankcase heater.
- B. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
- C. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of sound from the compressors into the building area.
- D. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) (insulated hot gas line) and insulated suction line.
- E. Unit shall include a factory holding charge of R-410A refrigerant and oil.
- F. Each capacity stage shall be equipped with a 5 minute off delay timer to prevent compressor short cycling. Each capacity stage shall be equipped with an adjustable 20 second delay timer to prevent multiple capacity stages from starting simultaneously.
- G. The unit shall be capable of stable cooling operation to a minimum of 55°F outdoor temperature.
- H. Lead (All) refrigeration circuit(s) shall include a 10-100% variable capacity compressor.
- I. Lead refrigeration circuit shall be provided with modulating hot gas reheat valves, electronic controller, liquid line receiver, supply air temperature sensor and a dehumidification control signal terminal that enables the dehumidification mode of operation, and includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. The matching indoor air handler must include a hot gas reheat coil.
- J. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall each be equipped with a liquid line filter drier with check valve, reversing valve, accumulator, and

thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump heating mode of operation.

- K. System shall be equipped with automatic reset low pressure switches and manual reset high pressure refrigerant controls.
- L. Unit shall be equipped with Schrader type service fittings on both the high side and low pressure sides of the system.
- M. Unit shall be equipped with replaceable core refrigerant liquid line driers with isolation valves.
- N. Each system shall be factory charged with 15 pounds of refrigerant.
- O. Each compressor shall be individually staged for capacity control.
- P. Field connections to each circuit shall be provided with ball type shutoff valves that shall be opened after the field connections are made and the all the field connected circuits have been properly evacuated.
- Q. All circuits shall be equipped with liquid line sight glasses.
- R. Each circuit shall be equipped with quarter turn, ball type, suction and discharge service valves and a service pressure tap.
- S. Lead (All) refrigeration circuit(s) shall be equipped with flooded condenser low ambient head pressure control to allow operation down to 0°F. Option includes adjustable compressor lockout, low ambient control valve, and liquid line receiver.
- T. Units shall be provided with a suction pressure transducer on the refrigeration circuit.
- U. Unit shall be provided with a compressor sound blanket.

2.9 CONTROLS

- A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, NEMA 3R molded case disconnect switch, factory wired with single point power connection. Factory mount disconnect switch on unit under provisions of Section 262717.
- B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.
- C. Provide safety controls arranged so any one will shut down machine:
 - 1. High discharge pressure switch (manual reset) for each compressor.
 - 2. Low suction pressure switch (automatic reset) for each compressor.
 - 3. Oil Pressure switch (manual reset).

D. Provide the following operating controls:

1. Unit to be provided with factory refrigeration controls to operate the condenser fans, compressors, valves, modulating hot gas reheat, etc. to maintain the supply discharge air conditions as determined by the Building Management System via BACnet connection.
 - a. Through the BACnet connection, the BMS shall be able to monitor the operation of the unit. The information shall provide the information to determine which compressors/condensers are operating, what speed/percent they are operating at, and what mode they are operating in addition to the following information:
 - 1) Current position of Modulating Hot Gas Reheat Valve.
 - 2) Compressor Modulating Cooling/Heating Signal (for all unit compressors)
 - 3) Condenser Signal (for all unit condensers)
 - 4) Compressor Suction Pressure (for all unit compressors)
 - 5) Compressor Head Pressure (for all unit compressors)
 - 6) Compressor Coil Saturation Temperature (for all compressors)
 - 7) Compressor Suction Line (cooling and heat pump) Temperature (for all compressors)
 - 8) Compressor (cooling and heat pump) Superheat Temperature (for all compressors)
 - 9) Compressor Expansion Valve Position (for all compressors)
 - 10) Condenser Expansion Valve Position (for all condensers)
2. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimized defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall de-energize, and auxiliary heat shall energize.

E. Standard Terminal Block

1. Unit shall be provided with a terminal block for field installation of controls.

F. Provide controls to permit operation down to 0 degrees F ambient temperature.

1. Thermostat to cycle fan motors in response to outdoor ambient temperature.

- 2. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
- 3. Solid state control to vary speed of condenser fans in response to refrigerant condensing pressure.
- G. Gauges: Prepped for suction and discharge refrigerant pressures and oil pressure for each compressor.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install unit in accordance with manufacturer's installation instructions.
- B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- C. Provide for connection to electrical service. Refer to Section 260583.
- D. Install units on structural steel framing as indicated.
- E. Provide connection to refrigeration piping system and evaporators. Refer to Section 232300. Comply with ASHRAE Std 15.

3.2 SYSTEM STARTUP

- A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- B. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
- C. Inspect and test for refrigerant leaks every three months during first year of operation.

END OF SECTION

SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

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 energy recovery units for exterior rooftop installations.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Motor Requirements for HVAC Equipment" for electrical motors that are an integral part of energy recovery units specified in this Section.
 - 2. Division 23 Section "Air Duct Accessories" for dampers and duct accessories that are an integral part of energy recovery units specified in this Section

1.3 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: For each type of energy recovery unit indicated. Include the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified energy recovery unit exchanger core summer and winter performance ratings.
 - 4. Motor ratings, electrical characteristics, and motor and fan accessories.
 - 5. Material gages and finishes.
 - 6. Filters with performance characteristics.
 - 7. Dampers, including housings, linkages, and operators.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights. AHU shall be constructed to ASCE 7, with reference to Mechanical & Electrical components design.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Unit structural frame construction detail drawings.

5. Unit casing panel construction detail drawings.
 6. Unit sub floor drawings.
 - D. Coordination Drawings: Submit with Shop Drawings. Show equipment layout and relationships between components and adjacent structure, mechanical elements, and other trades. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
 - E. Manufacturer Seismic Qualification Certification: Submit certification that energy recovery unit, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - F. Field Quality-Control Test Reports: From manufacturer.
- 1.4 QUALITY ASSURANCE
- A. Source Limitations: Obtain energy recovery units through one source from a single manufacturer.
 - B. ETL Certification: Air-handling units and their components shall be factory tested according to ETL, "Central-Station Air-Handling Units," and shall be listed and labeled by ETL.
 - C. Units shall be manufactured in an ISO 9001-2000 and ISO 14001-2004 certified facility.
 - D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - E. NFPA Compliance: Energy recovery units and components shall be designed, fabricated, and installed in compliance with NFPA 90A-2015, "Installation of Air Conditioning and Ventilating Systems."
 - F. ARI Certification: Energy recovery units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
 - G. Comply with NFPA 70-2017.

- H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2016, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

1.5 COORDINATION

- A. Coordinate size and location of structural-steel support members.

1.6 WARRANTY

- A. Manufacturer warrants to Buyer that for a period of eighteen months from the date of shipment by Manufacturer the goods to be delivered to Buyer will in all material respects be free from defects in material and workmanship when used in a proper and normal manner. Should any failure to conform to the above appear within eighteen months after the date of shipment by Manufacturer (the "Limited Warranty Period"), Manufacturer agrees upon prompt notification thereof during the Limited Warranty Period and confirmation to Manufacturer's satisfaction that the goods have been stored, installed, operated and maintained properly and in accordance with standard industry practice, to correct the non-conformity at Manufacturer's option either by repairing any defective part or parts or by making available at Manufacturer's plant a repaired or replacement part.
- B. Core Warranty. Manufacturer shall warrant to the buyer for a period of 60 months that the core in the energy recovery unit in all material respects to be free from defects in material and workmanship when used in a proper and normal manner.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Two sets of filters for each energy recovery unit. One set to be installed by the contractor prior to air balance and the other set to be turned over to the owner for inventory.
 - 2. Gaskets: One set for each access panel and door.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All energy recovery units are to be from a single manufacturer.
- B. Available Manufacturers: Subject to compliance with requirements, available manufacturers whose products may be incorporated into the Work include only those listed below. Any manufacturer's series, other than the Basis of Design manufacturer's series noted below and on the drawings, proposed as a substitution shall: (1) Have a preliminary submittal furnished not later than one week in advance of bid deadline for Engineer of Record (EOR) review. The manufacturer's series must be accepted in writing by the EOR in advance of bid deadline, or shall not be carried by any bidder. (2) Be submitted as a substitution to not only demonstrate manufacturer's series compliance with the requirements, but also demonstrate equivalency to

the Basis of Design series. The mechanical, plumbing, and electrical designs are based upon the Basis of Design manufacturer's series equipment. If other than the Basis of Design manufacturer's series is furnished and: (1) if the power requirements differ, the mechanical contractor shall coordinate all requirements with the electrical contractor including circuit breaker, conductor, and conduit sizes. In such case, the power shall still come from the same panel as currently designed. (2) if the piping or duct connections locations or sizes differ, the mechanical contractor shall coordinate with affected trades and shall provide all required modifications to accommodate. The mechanical contractor is responsible for any additional cost to any trade as noted above and as required to coordinate installation and provide proper service clearances for other than the Basis of Design manufacturer's series. The mechanical contractor is responsible for paying any design fees associated with redesigning architectural, structural, or MEP systems to accommodate other than the Basis of Design manufacturer's series.

1. Petra Engineering Industries Company, PAH series
2. Tempeff North America Ltd., RG series Dual Core Plus™ series (Basis of Design)
3. Annexair, Dual Core Series
4. Substitutions: See Section 01 6000 Product Requirements and Section 01 2500 Substitution Procedures.

2.2 ENERGY RECOVERY UNITS

- A. Energy recovery units shall be factory assembled and consist of supply fans, return fans, motors and drive assemblies, plenums, filters, dual energy recovery cores, condensate pans, dampers and damper actuators, electrical components, control devices, unit controls, and accessories.
- B. Fabricate draw through type double wall unit suitable for the capacities as scheduled. All internal components specified in the schedule shall be factory furnished, installed and shipped at the same time. The mechanical contractor shall field verify maximum allowable module size prior to ordering. The mechanical contractor is responsible for costs associated with shipping splits. The energy recovery unit capacity shall meet or exceed that indicated on the drawings.
- C. Provide all necessary tags and decals to aid in the service or to indicate caution areas.
- D. Electrical wiring diagrams shall be attached to the control panel access door.
- E. A minimum of two (2) sets of installation and maintenance manuals shall be provided with the energy recovery unit.
- F. CASING:
 1. Energy recovery unit construction shall be double wall with 22 gauge minimum, G-90 galvanized steel on both sides and a thermal break with no metal path from inside to outside the cabinet. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel. Casing to be perforated for interior walls and roof of fan section, solid in all other sections.

2. Energy recovery unit insulation shall have a minimum thermal resistance R-value of 12.6 at 75 deg F mean temperature. Expandable polyiso foam insulation, minimum 2" thick, shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
3. Energy recovery unit shall be constructed of 4" welded G-90 galvanized 10 gauge steel C-channel members on the full perimeter of the unit, with internal cross member supporting beams to support the internal components along the whole base length and width. Pedestal feet shall not be accepted.
4. Energy recovery unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access panels/access doors and openings to reduce air leakage. Electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access panels and access doors.
6. Access to filters, dampers, supply fans, exhaust fans, energy recovery unit exchanger core, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Galvanized steel outer and inner shall also be coated with (2) coats of electrostatic polyester powder coating, oven baked, which can meet minimum 5,000 hour salt spray according to ASTM standard B117 A&B. The base shall be coated with a double epoxy coating.
8. Furnish each energy recovery unit exchanger core with a double-sloped 304 stainless steel drain pan in compliance with ASHRAE 62.1-2013. If pan is not integral with the unit floor, pan shall be insulated and double wall.
9. Energy recovery unit shall be provided with base discharge and return air openings. All openings through the base pan of the energy recovery unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Energy recovery unit shall include lifting lugs on the top of the unit.
11. All hardware, including but not limited to nuts, bolts, washers, screws, etc. shall be stainless steel.
12. Units to be provided with OA/EA hoods where required. Intake hoods shall have mesh moisture eliminating filters and will be shipped loose for field installation. Hoods shall have bird screens.
13. Provide 18" tall full perimeter 2" insulated roof curbs for each energy recovery unit. Provide duct rails for field installed ductwork support. Curb to come with nailer for field

installed flashing. Comply with Division 23 Section "Vibration and Seismic Controls for HVAC."

- G. ACCESS - Access to components shall be provided through large, tightly sealed and easily removable or hinged access panels and doors. Access panels and doors shall be constructed of the same materials and finish as the energy recovery unit casing and use manufacturer's standard hardware. Panels and roof shall be removable without affecting the structural integrity of the unit. The cores shall be easily removable from the unit.
- H. UNIT CONFIGURATION - The supply air inlet and exhaust air outlet must be oriented at opposite ends of the Energy Recovery System to maximize the distance between the two airstreams in order to minimize the risk of short circuiting exhaust air into the supply air intake.
- I. FANS - Fans shall be Comefri USA, or equal, un-housed, backward curved, airfoil blade, single width, single inlet, direct drive plenum fans with inlet cones designed for optimal airflow through the impeller. The blades shall be designed for maximum efficiency and quiet operation. The fans shall be balanced over the entire range of fan operation (30% to 100% of RPM.) Filter in measurements shall not exceed 5 mills in the horizontal direction and vertical planes, and filter out measurements shall not exceed 7.5 mills in the horizontal, vertical, and axial planes. Fans shall be direct drive using ECM (electronically commutated motor) variable speed ball bearing type. The ECM fan motor shall provide soft starting and ability to vary the static differential pressure and airflow rate via its control board. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. The motors shall be mounted on the same isolation base as the fan. The motor shall be on a base that is adjustable in two (2) planes. After final assembly, the fan and motor assembly shall be factory balanced for 10% to 100% of the design speed of the energy recovery unit.
 - 1. Variable frequency drives for the fans shall be factory wired and mounted in the unit.
 - 2. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 200,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 of 200,000 hours.
- J. Accubloc Heat Exchanger (dual core) by Polybloc AG, or equal
 - 1. Comprising of a single module consisting of 2 aluminum energy (both latent and sensible) recovery unit exchanger cores (regenerative energy recovery) which can be removed for cleaning if necessary. Manufacturers using cores based on non-aluminum materials that require periodic replacement shall provide the owner with 2 spare cores for future use and storage. Cores exchanging sensible heat only shall not be accepted.
 - 2. Upstream and downstream damper system to change and rotate air path from each core during operation.
 - 3. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery (due to sorption coating.) Unit shall accomplish this recovery without a defrost cycle that will reduce the

effectiveness of the device. Devices employing defrost cycles that bypass the energy recovery device, or reduce the effectiveness are not acceptable. Energy recovery device shall not require frost protection in applications down to -40 degrees.

4. Temperature efficiency up to 95%, moisture recovery up to 75% (.)
5. Optional sorption coating to allow for latent transfer in winter and summer alike.
6. Low leakage air rate.
7. Casing made from a molded aluminum C-channel profile.
 - a. Aluminum damper shafts
 - b. Galvanized steel drive shaft
 - c. Pressed into fin profile core reinforcement and seated on oil-soaked bronze friction bearings, and dust proof all bearings on each side.
 - d. Fins have counter rotating connection and are specially designed for high wear resistance during continuous operation through dust proof permanently lubricated ball bearings.
8. Control
 - a. Non contact, full electronic version for high wear resistance during continuous operation.
 - b. subject to output demand via external 0-10Vdc signal and an enabling contact.
 - c. Output relay for fault display

K. DAMPERS

1. Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators. Pneumatic actuators are not acceptable. 800 CFM-7,000 CFM shall have damper switching times of 0.75 seconds. 7000 CFM-75,000 CFM shall have damper switching times of 1.25 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable. This switch over must limit any internal cross leakage below 3%. Test report must be provided showing that the damper configuration meets this requirement. Testing must use the tracer gas method prescribed by ASHRAE 84.
 - a. Single blade damper sections are not acceptable. Each damper shall control one of the 4 airways, upper-horizontal, lower-horizontal, forward-vertical and rear-vertical. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers.
 - b. Dampers shall also be capable of orienting to allow 100% recirculation of air without using heat recovery device for off peak or unoccupied heating modes. Units incapable of these operations without extra ductwork are not acceptable. Re-circ design must be capable of pre-warming both heat exchangers simultaneously for morning warm-up cycle. Strategies that only warm one heat exchanger is unacceptable.

- c. Damper seals shall be ½" heavy thickness EPDM bulb seal. Single blade seals are unacceptable due to high leakage and poor sealing.
 - d. Damper bearings shall be heavy duty greasable pillow block flange bearings. Bronze or plastic bearings are not acceptable due to high cycle requirements. Bearings shall have a minimum diameter:
 - 1) 800-7000 CFM: ¾" Bearings, maximum of 4 shafts per unit
 - 2) 7,000 – 21,000 CFM: 1" Bearings, maximum of 4 shafts per unit
 - 3) 21,000 CFM and larger – 1" Bearings, maximum of 6 shafts per unit
 - e. Damper shafts shall be large diameter shafts meeting:
 - 1) 800-7,000 CFM ¾" Chromium Shafts, maximum of 4 shafts per unit
 - 2) 7,000 – 21,000 CFM - 1" Chromium Shafts, maximum of 4 shafts per unit
 - 3) 21,000 CFM and larger – 2" Diameter Steel shafts, maximum of 6 shafts per unit
 - 4) Technologies employing smaller diameter shafts, or more shafts per unit are unacceptable as that would be considered light duty, and insufficient to withstand the demanding nature of the application.
 - f. Damper manufacturer must provide written documentation that the dampers are capable of a minimum duty cycle of 500,000 cycles annually. Damper Manufacturer shall provide a written warranty on damper manufactures letterhead confirming the warranty.
 - g. Recovery cycles shall be controlled by internal programmed thermostats measuring both supply and exhaust air, and optimizing performance of both heat recovery and free cooling modes.
- 2. External shutoff insulated control dampers and actuators shall be factory installed and meet Division 23 Section "Air Duct Accessories."
- L. RETURN AIR SIDE FINAL FILTERS – Provide filters on the return air inlet to the energy recovery unit.
- 1. Extended-Surface, Nonsupported-Media Filters:
 - 2. Provide minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 3. 4 inch thick minimum MERV 8 (ASHRAE 52.2) pleated panel filters operating not greater than 300 fpm.
 - 4. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.
 - 5. Filter-Media Frame: Galvanized steel.
 - 6. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

7. Provide filter access doors on both sides of unit. All filters shall be removable from either side.
- M. OUTDOOR AIR SIDE FINAL FILTERS – Provide final filters on the outdoor air inlet to the energy recovery unit.
1. Extended-Surface, Nonsupported-Media Filters:
 2. Provide minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 3. 4 inch thick minimum MERV 13 (ASHRAE 52.2) pleated panel filters operating not greater than 300 fpm.
 4. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.
 5. Filter-Media Frame: Galvanized steel.
 6. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.
 7. Provide filter access doors on both sides of unit. All filters shall be removable from either side.
- N. ELECTRICAL
1. Single point electrical connection and factory provided and wired non-fused disconnect switch.
 2. Mechanical contractor shall verify the mechanical equipment, including motor controllers and variable frequency drives furnished under the mechanical contract, short circuit current rating (SCCR) is selected and coordinated to accommodate the minimum available fault current at the location it is installed. This shall be based on the Power System Study results performed under the electrical contract. Where the Power System Study is not available prior to the equipment submission process, it shall be assumed that any equipment rated 10 horsepower and above shall have an SCCR rating of no less than 10,000 amperes. Equipment shall be provided with an SCCR label as required by the National Electrical Code.
 3. Furnish control power transformer within control box.
 4. See schedule for additional electrical requirements.
 5. Units shall be provided with factory wired, 115V, 12A GFCI convenience outlet.
- O. The DDC shall monitor entering and leaving temperatures for the exhaust and supply air. Adjustable set points shall be for the heating mode discharge temperature, summer/winter change over and for frost control.
- P. Controls: Controls shall be Factory Installed and Factory Provided
1. Energy recovery unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and

- factory tested. Controller shall be capable of stand alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
2. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 3. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 4. Variable Air Volume Controller
 - a. Energy recovery unit shall utilize variable speed supply and exhaust fans and modulate airflow as required by the sequence of operation.
 5. Energy recovery unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.
 6. Furnish with factory installed supply air smoke detector.
 7. Provide terminal strip for field connection to BAS system.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install energy recovery units with the following vibration and seismic control devices. Vibration and seismic control devices are specified in Division 23 Section "Mechanical Vibration and Seismic Controls."
 1. Roof-Mounted Units: Support structural steel, vibration isolated roof curb with seismic restraining devices. Curb to be 18" tall full perimeter, 2" insulated with nailer for field installed flashing.

- B. Arrange installation of energy recovery units to provide access space around units for service and maintenance.

3.3 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- B. Pipe condensate drains from energy recovery units and drain pans to nearest equipment, roof, or floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- C. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Final Checks before Startup: Perform the following:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that energy recovery unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align, and install guards.
 - 5. Lubricate bearings and other moving parts with factory-recommended lubricants.

6. Install clean filters.
 7. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- C. Starting procedures for energy recovery units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for modular indoor air-handling system testing, adjusting, and balancing.
- 3.6 CLEANING
- A. Clean energy recovery units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and filter housings before installation of filters and testing, adjusting, and balancing.
- B. Energy recovery units are not to be used to condition the space during construction, except to perform startup. Accordingly, the installed filters are expected to be clean during air balance and at time of substantial completion.
- C. After completing installation of energy recovery units, inspect exposed finishes and repair damaged finishes.
- 3.7 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel for one day to adjust, operate, and maintain energy recovery units. Refer to Division 01 Section Closeout Procedures.

END OF SECTION

SECTION 238129 - VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable refrigerant volume HVAC system includes:
 - 1. Outdoor/condensing unit(s).
 - 2. Indoor/evaporator units.
 - 3. Branch selector units.
 - 4. Refrigerant piping.
 - 5. Control panels.
 - 6. Control wiring.

1.2 SYSTEM DESCRIPTION

- A. Variable capacity, split system heat pump heat recovery air conditioning system. The system shall be capable of simultaneous cooling and heating. The system shall consist of an outdoor unit with variable flow compressors, BC (Branch Circuit) Controller, multiple indoor units, and Direct Digital Controls capable of interfacing with the building automation system. Each indoor unit shall be capable of operating in any mode independently of other indoor units.
- B. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation.
- C. To ensure owner comfort, each indoor unit shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes.
- D. The sum of connected capacity of all indoor air handlers shall range from 50% to 130% of outdoor rated capacity.
- E. Designed for low ambient heating capability.

1.3 RELATED REQUIREMENTS

- A. Section 017900 - Demonstration and Training.
- B. Section 221005 - Plumbing Piping: Condensate drain piping.
- C. Section 223000 - Plumbing Equipment: Cooling condensate removal pumps.
- D. Section 232300 - Refrigerant Piping: Additional requirements for refrigerant piping system.
- E. Section 260583 - EQUIPMENT WIRING: Power connections to equipment.

1.4 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.
- B. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010, with 2013 Supplements and Errata.
- C. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2017.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2013, Including All Amendments and Errata.
- E. ITS (DIR) - Directory of Listed Products; current edition.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. Pre-Bid Submittals: For proposed substitute systems/products, as defined in PART 2, and alternate systems/products, as defined above, proposer shall submit all data described in this article, under the terms given for substitutions stated in PART 2.
- B. Design Data:
 - 1. Provide design calculations showing that system will achieve performance specified.
 - 2. Provide design data required by ASHRAE 90.1.
- C. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:
 - 1. Outdoor/Central Units:
 - a. Refrigerant Type and Size of Charge.
 - b. Cooling Capacity: Btu/h.
 - c. Heating Capacity: Btu/h.
 - d. Cooling Input Power: Btu/h.
 - e. Heating Input Power: Btu/h.
 - f. Operating Temperature Range, Cooling and Heating.
 - g. Air Flow: Cubic feet per minute.
 - h. Fan Curves.

- i. External Static Pressure (ESP): Inches WG.
- j. Sound Pressure Level: dB(A).
- k. Electrical Data:
 - 1) Maximum Circuit Amps (MCA).
 - 2) Maximum Fuse Amps (MFA).
 - 3) Maximum Starting Current (MSC).
 - 4) Full Load Amps (FLA).
 - 5) Total Over Current Amps (TOCA).
 - 6) Fan Motor: HP.
- l. Weight and Dimensions.
- m. Maximum number of indoor units that can be served.
- n. Maximum refrigerant piping run from outdoor/condenser unit to indoor/evaporator unit.
- o. Maximum height difference between outdoor/condenser unit to indoor/evaporator unit, both above and below.
- p. Control Options.
- 2. Indoor/Evaporator Units:
 - a. Cooling Capacity: Btu/h.
 - b. Heating Capacity: Btu/h.
 - c. Cooling Input Power: Btu/h.
 - d. Heating Input Power: Btu/h.
 - e. Air Flow: Cubic feet per minute.
 - f. Fan Curves.
 - g. External Static Pressure (ESP): Inches WG.
 - h. Sound Pressure level: dB(A).
 - i. Electrical Data:
 - 1) Maximum Circuit Amps (MCA).
 - 2) Maximum Fuse Amps (MFA).
 - 3) Maximum Starting Current (MSC).
 - 4) Full Load Amps (FLA).
 - 5) Total Over Current Amps (TOCA).

- 6) Fan Motor: HP.
- j. Maximum Lift of Built-in Condensate Pump.
- k. Weight and Dimensions.
- l. Control Options.
- 3. Control Panels: Complete description of options, control points, zones/groups.
- D. Specimen Warranty: Copy of manufacturer's warranties.
- E. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
 - 1. Detailed piping diagrams, with branch balancing devices.
 - 2. Condensate piping routing, size, and pump connections.
 - 3. Detailed power wiring diagrams.
 - 4. Detailed control wiring diagrams.
 - 5. Locations of required access through fixed construction.
 - 6. Drawings required by manufacturer.
 - 7. In addition to paper copies, submit shop drawings as CAD files in DXF format.
 - 8. Architect will furnish CAD files for use in preparing shop drawings.
- F. Operating and Maintenance Data:
 - 1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 - 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 - 3. Identification of replaceable parts and local source of supply.
- G. Project Record Documents: Record the following:
 - 1. As-installed routing of refrigerant piping and condensate piping.
 - 2. Locations of access panels.
 - 3. Locations of control panels.
- H. Warranty: Executed warranty, made out in Owner's name.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:

1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 20 years.
 - B. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
 - C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
 - D. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
- 1.7 DELIVERY, STORAGE AND HANDLING
- A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.
- 1.8 WARRANTY
- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
 - B. The units shall be covered by the manufacturer's limited warranty for a period of five (5) years from date of installation.
 - C. Compressors: Provide manufacturer's warranty for seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty shall include labor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: The system design shown in the contract documents is based on equipment and system designed by Daikin AC; www.daikinac.com.
- B. Systems designed and manufactured by other manufacturers will be considered by Owner under the terms described for substitutions with the following exceptions:
 1. Substitution requests will be considered only if received at least 10 days prior to the bid date.
 2. Substitution requests will be considered only if required submittal data is complete; see article SUBMITTALS above.
 3. Contractor (not equipment supplier) shall certify that the use of the substitute system and equipment will not require changes to other work or re-design by Architect.
 4. Contractor or HVAC subcontractor shall certify that the substitute system will achieve the performance specified.

5. Do not assume substitution has been accepted until formal written notice has been issued by Architect.

2.2 HVAC SYSTEM DESIGN

A. System Operation: Heating and cooling, simultaneously.

1. Zoning: Provide capability for temperature control for each individual indoor/evaporator unit independently of all other units.
2. Zoning: Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.
 - a. Exception: Where indicated, multiple indoor/evaporator units may be controlled in groups.
3. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
4. Conditioned spaces are indicated on drawings.
5. Outdoor/Condenser unit locations are indicated on drawings.
6. Indoor/Evaporator unit locations are indicated on drawings.
7. Branch Circuit (BC) Controller unit locations are shown on the drawings.
8. Required equipment unit capacities are indicated on drawings.
9. Refrigerant piping sizes are shown on the drawings.
10. Connect equipment to condensate piping provided by others; condensate piping is indicated on drawings.

B. Cooling Mode Interior Performance:

1. Daytime Setpoint: 68 degrees F, plus or minus 2 degrees F.
2. Setpoint Range: 57 degrees F to 77 degrees F.
3. Night Setback: 78 degrees F.
4. Interior Relative Humidity: 50 percent, maximum.

C. Heating Mode Interior Performance:

1. Daytime Setpoint: 72 degrees F, plus or minus 2 degrees F.
2. Setpoint Range: 59 degrees F to 80 degrees F.
3. Night Setback: 65 degrees F.
4. Interior Relative Humidity: 10 percent, minimum.

D. Outside Air Design Conditions:

1. Summer Outside Air Design Temperature: 0.4 percent cooling design condition listed in ASHRAE Fundamentals Handbook - ASHRAE (FUND).
 2. Winter Outside Air Design Temperature: 99.6 percent heating design condition listed in ASHRAE Fundamentals Handbook - ASHRAE (FUND).
- E. Energy Design Wind Speed: 25 mph.
- F. Operating Temperature Ranges:
1. Simultaneous Heating and Cooling Operating Range: minus 4 degrees F to 60 degrees F dry bulb.
 2. Cooling Mode Operating Range: minus 10 degrees F to 110 degrees F dry bulb.
 3. Heating Mode Operating Range: minus 22 degrees F to 77 degrees F dry bulb; minus 22 degrees F to 60 degrees F wet bulb; without low ambient controls or auxiliary heat source.
- G. Refrigerant Piping Lengths: Provide equipment capable of serving system with following piping lengths without any oil traps:
1. Maximum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 541 feet, actual; 541 feet, equivalent without the need for line size change or traps.
 2. Maximum Vertical Distance Between Outdoor/Central Unit(s) and Terminal Units: 164 feet.
- H. Controls: Provide the following control interfaces:
1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where indicated.
 2. BACNet gateways sufficient to connect all units to building automation system by others; include wiring to gateways.
 3. Building automation system by HVAC system manufacturer; provide one user stations located where indicated.
- I. Local Controllers: Wall-mounted, wired, containing temperature sensor.
- J. Remote Temperature Sensors: In addition to temperature sensors integral with indoor/evaporator units, provide wall-mounted, wired remote temperature sensors located in the same room for the following:
1. In-ceiling mounted units.
 2. On-ceiling mounted units.
 3. Wall mounted units mounted up high.
 4. Concealed console units.
 5. Exposed console units.

6. Exception: Where a local controller with temperature sensor is provided for the particular unit and is located in the same space.

2.3 EQUIPMENT

- A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.
 1. Refrigerant: R-410A.
 2. Performance Certification: AHRI Certified; www.ahrinet.org.
 3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
 4. Provide outdoor/condensing units capable of serving indoor unit capacity ranging from 50% to 130% of outdoor rated capacity.
 5. Provide units capable of serving the zones indicated.
 6. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.
 7. Outdoor Units: Units and their supports designed and installed to resist wind pressures defined in ASCE 7.
- B. Electrical Characteristics:
 1. Power - Condensing Units: 208 to 230 Volts, 3-phase, 60 Hz.
 2. Power - Branch Selector Units: 208 to 230 Volts, single phase, 60 Hz.
 3. Power - Indoor Units: 208 to 230 Volts, single phase, 60 Hz.
 4. 208-230 Voltage Range: 187 to 253 volts.
 5. Control: 16 volts DC.
- C. System Controls:
 1. Include self diagnostic, auto-check functions to detect malfunctions and display the type and location.
- D. Remote Centralized Control Panel:
- E. Unit Controls: As required to perform input functions necessary to operate system; provided by manufacturer of units.
 1. Provide interfaces to remote control and building automation systems as specified.
- F. Wiring:
 1. Control Wiring: 18 AWG, 2-conductor, non-shielded, non-polarized, stranded cable.
 2. Control Wiring Configuration: Daisy chain.

G. Refrigerant Piping:

1. Provide three-pipe refrigerant system, including liquid, suction and hot gas refrigerant lines.
2. All refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated. Pre-insulated line sets shall be acceptable.
3. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.
4. Provide three-pipe refrigerant system, including high/low pressure dedicated hot gas, liquid and suction lines; two-pipe systems utilizing lower temperature mixed liquid/gas refrigerant to perform heat recovery are not permitted due to reduced heating capabilities.
5. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance; T-style joints are prohibited.
6. Insulate each refrigerant line individually between the condensing and indoor units.

2.4 REFRIGERANT

- A. Refrigerant: R410A refrigerant shall be required for outdoor unit systems.
- B. Oil: Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

2.5 OUTDOOR/CONDENSING UNITS

- A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.
 1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
 2. Refrigerant: Factory charged.
 3. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 4. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
 5. Capable of being connected to up to 50 indoor units.
 6. Capable of being installed with wiring and piping to the left, right, rear or bottom.

7. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
 8. Sound Pressure Level: As specified, measured at 3 feet from front of unit; provide night setback sound control as a standard feature; Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 64 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation.
 9. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
 10. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 11. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 12. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
 13. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
 14. Oil Separator: Unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 15. Defrost: Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
 16. Controls: Provide contacts for electrical demand shedding.
- B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
1. Designed to allow side-by-side installation with minimum spacing.
 2. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
 3. Provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
- C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.
1. External Static Pressure: Factory set at 0.0 in WG, minimum, but capable of normal operation under a maximum of 0.24 in WG external static pressure via dipswitch.

2. Fan Airflow: As indicated for specific equipment.
 3. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.
- D. Condenser Coils: Copper tubes expanded into aluminum plate fins to form mechanical bond; lanced or corrugated fin and rifled bore tube design to ensure high efficiency performance.
1. Corrosion Protection: Fins coated with anti-corrosion acrylic resin and hydrophilic film type E1; pipe plates coated with powdered polyester powder coating of 2.0 to 3.0 microns thickness.
- E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
1. Variable Speed Control: Capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure; high/low pressures calculated by samplings of evaporator and condenser temperatures every 20 seconds, with compressor capacity adjusted to eliminate deviation from target value by changing inverter frequency or on/off setting of fixed speed compressors.
 2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
 3. Inverter Driven Compressors: PVM inverter driven, highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G2-type" with maximum speed of 7,980 rpm.
 4. Rotors: Incorporating neodymium magnets for higher torque and efficiency; at complete stop of compressor, position rotor into optimum position for low torque start.
 5. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
 6. Provide oil separators and intelligent oil management system.
 7. Provide spring mounted vibration isolators.
- F. Electrical:
1. The unit electrical power shall be 460 volts, 3 phase, 60 hertz.
 2. The unit shall be capable of satisfactory operation within voltage limits of 414-506V (460V/60Hz).
 3. The outdoor unit shall be controlled by integral microprocessors.
 4. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.6 BRANCH CIRCUIT (BC) CONTROLLER UNITS

- A. Branch Circuit Controller Units: Concealed boxes designed specifically for this type of system to control heating/cooling mode selection of downstream units; The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit performance;
1. Controllers shall be specifically used with R410A R2-Series systems. The units shall be equipped with a circuit board that interfaces to the control system and shall perform all functions necessary for operation. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity
 2. Control direction of refrigerant flow using Linear electronic expansion valves for changeover and pressure equalization.
 3. When branch unit is simultaneously heating and cooling, energize subcooling heat exchanger.
 4. Casing: Galvanized steel sheet; with flame and heat resistant foamed polyethylene sound and thermal insulation.
 - a. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
 - b. The unit shall house two tube-in-tube heat exchangers.
 5. Refrigerant Connections: Braze type.
 6. Condensate Drainage: Provide unit with integral condensate drain pan.
 7. Refrigerant valves:
 - a. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
 - b. Each branch shall have multiple two-position valves to control refrigerant flow.
 - c. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
 - d. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
 8. Electrical:
 - a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.

- b. The unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz).
- c. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.7 INDOOR/EVAPORATOR UNITS

- A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - 1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
 - 2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
 - 3. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
 - a. Provide thermistor on liquid and gas lines.
 - 4. Fans: Direct-drive, with statically and dynamically balanced impellers; high, mid and low speeds unless otherwise indicated; motor thermally protected.
 - a. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 5. Return Air Filter: Washable long-life net filter with mildew proof resin, unless otherwise indicated.
 - 6. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.
 - a. Units With Built-In Condensate Pumps: Provide condensate safety shutoff and alarm.
 - b. The units shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan
 - 7. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.
- B. Recessed Ceiling Units - 2 FT by 2 FT: Four-way airflow cassette with central return air grille, sized for installation in standard 24 by 24 inch lay-in ceiling grid.
 - 1. Cabinet Height: Maximum of 12 inches above face of ceiling.
 - 2. Exposed Housing: White, impact resistant, with washable decoration panel.
 - 3. Maintenance Access: All electrical components accessible through decoration panel.
 - 4. Supply Airflow Adjustment:
 - a. Via motorized louvers which can be horizontally and vertically adjusted from 0 to 90 degrees.

- b. Field-modifiable to 4-way, 3-way or 2-way airflow.
 - c. Three auto-swing positions, including standard, draft prevention and ceiling stain prevention.
 - 5. Sound Pressure: Measured at low speed at 5 feet below unit.
 - 6. Fan: Direct-drive turbo type.
 - 7. Condensate Pump: Built-in, with lift of 23 inches, minimum.
 - 8. Provide side-mounted supply air branch duct connection.
 - 9. Provide side-mounted fresh air intake duct connection.
- C. Concealed-In-Ceiling Units: Ducted horizontal discharge and return; galvanized steel cabinet.
 - 1. Return Air Filter: Manufacturer's standard.
 - 2. Sound Pressure: Measured at low speed at 5 feet below unit.
 - 3. Provide external static pressure switch adjustable for high efficiency filter operation
 - 4. Condensate Drain Pan: Provide an integral condensate drain pan with unit.
 - 5. Switch box accessible from side or bottom.
 - 6. Fan: External static pressure settings from 0.14 to 0.60 in. WG.
 - a. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor
 - b. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings
 - c. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function
 - d. The indoor unit shall have a ducted air outlet system and ducted return air system
- D. Wall Surface-Mounted Units: Finished white casing, with removable front grille; foamed polystyrene and polyethylene sound insulation; wall mounting plate; polystyrene condensate drain pan.
 - 1. Airflow Control: Auto-swing louver that closes automatically when unit stops; five (5) steps of discharge angle, set using remote controller; upon restart, discharge angle defaulting to same angle as previous operation.
 - 2. Sound Pressure Range: Measured at low speed at 3.3 feet below and away from unit.
 - 3. Condensate Drain Connection: Back, with piping concealed in wall.
 - 4. Fan: Direct-drive cross-flow type.
- E. Exposed Console Units: Top discharge grille, bottom return air; finished casing, sound-insulated with fiberglass urethane foam; auto-swing louver that closes automatically when unit stops.

1. Maintenance Access Required: Not more than 3/4 inch in rear, 4 inch on each side.
 2. Sound Pressure Range: Measured at high speed at 5 feet away and 5 feet above floor.
 3. Fan: Sirocco type.
- F. Concealed Console Units: Top discharge grille, bottom return air; unfinished casing, sound-insulated with fiberglass urethane foam; auto-swing louver that closes automatically when unit stops.
1. Maintenance Access Required: Not more than 3/4 inch in rear, 4 inch on each side.
 2. Sound Pressure Level: Measured at high speed measured at 5 feet away and 5 feet above floor.
 3. Fan: Sirocco type.
- G. Air Handling Units: Factory-painted heavy gage steel casing insulated with sound absorbing foil faced insulation.
1. Horizontal Right Configuration: Horizontal discharge air and horizontal return air.
 2. Secondary condensate drain pan; field installed.
 3. Fan: Direct-drive ECM type fan with automatic airflow adjustment.
 4. Provide air filter.
 5. External insulation; field installed.

2.8 CONTROLS

- A. Centralized Controller: Provide centralized controller capable of controlling up to a maximum of 50 indoor units.
1. The Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple outdoor units. The Centralized Controller shall be approximately 8-1/2"x10" in size and shall be powered from a built-in power supply to the system control transmission line. The Centralized Controller shall support operation superseding that of the remote controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. The Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the Centralized Controller shall include on/off, operation mode selection (cool, heat, auto, dry, and fan), temperature setting, fan speed setting, and airflow direction setting. Since the Centralized Controller shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Centralized Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, vane direction, fan speed, and permit/prohibit of remote controllers

2. The Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple outdoor units. .
 3. The Centralized Controller shall support operation superseding that of the remote controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.
 4. The Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the Centralized Controller shall include on/off, operation mode selection (cool, heat, auto, dry, and fan), temperature setting, fan speed setting, and airflow direction setting.
 5. The Contralized Controller shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Centralized Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, vane direction, fan speed, and permit/prohibit of remote controllers.
 6. The Centralized Controllers shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via a closed/direct Local Area Network (LAN).
- B. Building Automation System Integration: Provide all the required hardware and software to enable integration with Building Management Systems (BMS) via BACnet® interface.
1. The HVAC BACnet® interface shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet® Testing Laboratories.
 2. The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.
- C. Analog Input (AI) Board(s): Provide I/O board(s) capable of monitoring temperature or humidity.
1. Each AI board shall have two analog inputs. Each input shall be capable of receiving a 4/20mA, 0/10 VDC, or 1/5 VDC signal for monitoring temperature or humidity.
 2. The AI board shall be capable of monitoring the temperature or humidity input and shall be capable of displaying graphical trending of the temperature or humidity values.
 3. The AI board shall be capable of setting the following parameters on the indoor unit On/Off, Mode, and Set Temperature to predefined settings based on the input value of the temperature or humidity. The AI board shall also be capable of interlocking the On/Off state of a digital output on the input value of the temperature or humidity.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.
- B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.
- C. Notify Architect if conditions for installation are unsatisfactory.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Provide manufacturer's field representative to inspect installation prior to startup.

3.4 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform system startup.
- B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- C. Adjust equipment for proper operation within manufacturer's published tolerances.

3.5 CLEANING

- A. Clean exposed components of dirt, finger marks, and other disfigurements.

3.6 PROTECTION

- A. Protect installed components from subsequent construction operations.
- B. Replace exposed components broken or otherwise damaged beyond repair.

END OF SECTION

SECTION 238216 - AIR COILS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Refrigerant coils.

1.2 RELATED REQUIREMENTS

- A. Section 230719 - HVAC PIPING INSULATION.
- B. Section 232113 - Hydronic Piping.
- C. Section 232114 - Hydronic Specialties.
- D. Section 232300 - Refrigerant Piping.
- E. Section 233100 - HVAC Ducts and Casings: Installation of duct coils.

1.3 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.4 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit a schedule identifying every air coil, with tag numbers corresponding to those on the drawings.
- C. Product data: Hose kit component data. Submit a schedule identifying every hose kit, with hydronic coil tag numbers corresponding to those on the drawings.
- D. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- E. Certificates: Certify that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.7 WARRANTY

- A. See Section 017839 - Project Record Documents, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all coils.

PART 2 PRODUCTS

2.1 REFRIGERANT COILS

- A. Tubes: 3/8 inch OD seamless copper arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Fins: Aluminum or copper continuous plate type with full fin collars. Solder coat copper fin coils.
- C. Fin Thickness: 0.012
- D. Casing: Die formed channel frame of 16 gage ASTM A 666 Type 304 stainless steel with mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- E. Headers: Seamless copper or brass tubes with silver brazed joints.
- F. Liquid Distributors: Brass or copper venturi type distributor with seamless copper distributor tubes, 5/16 inch outside diameter; maximum 12 circuits per distributor.
- G. Testing: Air test under water at 300 psi for working pressure of 250 psi; clean, dehydrate, and seal with dry nitrogen charge.
- H. Configuration: Down feed with bottom suction to prevent trapping of oil.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).

1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
 2. Provide frames for maximum three coil sections.
 3. Arrange supports to avoid piercing drain pans.
 4. Provide airtight seal between coil and duct or casing.
 5. Refer to Section 233100.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Install coils level. Install cleanable tube coils with 1:50 pitch.
- E. Make connections to coils with unions and flanges.
- F. Cooling Coils:
1. Provide three break moisture eliminators of 24 gauge, 0.0239 inch galvanized steel, where air velocity exceeds 500 ft/min.
 2. Provide drain pan and drain connection; fabricate from 20 gauge, 0.0359 inch galvanized steel, extend 3 inches from face of entering air side, 6 inches from face of leaving air side, and 4 inches from face of eliminators. Pipe drain pans individually to floor drain with water seal trap.
- G. Refrigerant Coils: Provide sight glass in liquid line within 12 inches of coil. Refer to Section 232300.
- H. Insulate headers located outside air flow as specified for piping. Refer to Section 230719.

END OF SECTION

SECTION 250000 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 07 8413 - Penetration Firestopping: Through-penetration firestop systems. Also comply with firestopping requirements of Division 23 Section "Mechanical General Provisions.
- C. Section 26 0533.13 - Conduit for Electrical Systems.
- D. Section 26 0533.16 - Boxes for Electrical Systems.
- E. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- F. Section 28 4600 - Fire Detection and Alarm.

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. LAN: Local area network.
- C. MS/TP: Master-slave/token-passing.
- D. PICS: Protocol Implementation Conformance Statement.

1.4 REFERENCE STANDARDS

- A. NFPA 70-2017 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SYSTEM DESCRIPTION

- A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.
- B. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

- C. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- D. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- E. Control system includes the following:
 - 1. Fire alarm system specified in Division 28 Section "Fire Detection and Alarm."

1.6 SEQUENCE OF OPERATION

- A. As specified in the drawings

1.7 SUBMITTALS

- A. See Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. Each control device labeled with setting or adjustable range of control.
- C. Firestopping materials.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 3. Details of control panel faces, including controls, instruments, and labeling.
 - 4. Written description of sequence of operation.
 - 5. Schedule of dampers including size, leakage, and flow characteristics.
 - 6. Schedule of valves including leakage and flow characteristics.
 - 7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
 - 8. Listing of connected data points, including connected control unit and input device.
 - 9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- E. Coordination Drawings: Detail major elements, components, and systems of HVAC controls equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
1. Planned layout, including panels, actuators, and specialty locations.
 2. Clearances for installing and maintaining insulation.
 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 4. Equipment and accessory service connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 8. Reflected ceiling plans to coordinate and integrate installation of ceiling-mounted items.
- F. Prior to the purchasing of materials or the start of work, prepare a $\frac{1}{2}" = 1'-0"$ scale coordination drawing showing size, size and location of mechanical controls items relative to other trades. Distribute drawing to other trades, and Submit drawing to Design Professional for review and approval. No demolition or new work shall proceed until all trades have indicated their respective services on the coordination drawing, and the Engineer has reviewed and approved the coordination drawings. Coordination drawings shall not be utilized as the final as built drawings required in this specification.
- G. Samples: For each color required, of each type of thermostat cover.
- H. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or monitoring and control revisions.
- I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- J. Maintenance Data: For systems to include in maintenance manuals specified in Division 1. Include the following:
1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

- K. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- L. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70-2017, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Mechanical contractor shall verify the mechanical equipment, including motor controllers and variable frequency drives furnished under the mechanical contract, short circuit current rating (SCCR) is selected and coordinated to accommodate the minimum available fault current at the location it is installed. This shall be based on the Power System Study results performed under the electrical contract. Where the Power System Study is not available prior to the equipment submission process, it shall be assumed that any equipment rated 10 horsepower and above shall have an SCCR rating of no less than 10,000 amperes. Equipment shall be provided with an SCCR label as required by the National Electrical Code.
- E. Perform work in accordance with NFPA 70-2017, or latest edition adopted.
- F. Comply with NFPA 90A-2015, "Installation of Air Conditioning and Ventilation Systems."

1.9 DRAWINGS USE AND INTERPRETATION

- A. It is not the intention of the drawings to show every item, piece of equipment, and detail related to the project.
- B. The drawings are diagrammatical and indicate the general arrangement of systems and equipment, unless indicated otherwise by dimension or Detail Drawings. For exact locations of building elements, refer to dimensioned Architectural/Structural Drawings. However, field measurements take precedence over dimensioned drawings. The installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field

coordination drawing requirements specified in Division 1 – General Requirements, and the General Conditions.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.11 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- E. Coordinate equipment with Division 26 Section "Variable-Frequency Motor Controllers" to achieve compatibility with variable frequency drives, and annunciation devices.
- F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

1.12 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this Section.
- B. Require attendance of parties directly affecting the work of this Section.

1.13 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Replacement Materials: One replacement diaphragm or relay mechanism for each unique controller, thermostat, and positioning relay.

1.14 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one year(s) from Date of Substantial Completion.
- B. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

1.15 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers. No other manufacturer's products will be considered.
1. Electric, Electronic, and DDC Systems:
 - a. Temperature Controls of Vermont, Automated Logic.
 - b. No substitutions accepted unless otherwise approved by building owner.

2.2 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each input/output point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator station.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 - d. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - e. WEB Based.
 - f. BACNET Compatible
 3. Local operator interface provides for download from or upload to mobile operator station.

4. Controller to controller communications “bus” shall not operate at speeds below 156kbps.
 5. Controllers shall have the ability to retain commissioning notes in non-volatile memory.
 6. Controllers shall retain their own schedules and set points in non-volatile on board memory, and shall not look to, poll, or be polled by any global controller to accomplish said functionality.
 7. Controller shall have the ability to put analog and digital outputs into “hand-auto-off” mode and monitor the status of said switches for alarming purposes and graphical display.
 8. Controllers shall have built-in 24 VDC power supplies.
 9. All controllers shall have published PICS BACNET conformance.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each input/output point; process information; and download from or upload to operator station.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 - d. WEB Based.
 - e. BACNET Compatible
 3. Local operator interface provides for download from or upload to mobile operator station.
 4. Controller to controller communications “bus” shall not operate at speeds below 156kbps.
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 7. Controller shall have the ability to put analog and digital outputs into “hand-auto-off” mode and monitor the status of said switches for alarming purposes and graphical display.
 8. Controllers shall have built-in 24 VDC power supplies.
 9. All controllers shall have published PICS BACNET conformance.

- C. LAN Gate: Shall establish seamless interconnection between other electrical and mechanical subsystems. Shall provide communications between local control units and the graphical user interface.
- D. System Work Station: Provide a local work station with monitor for operator interface. Monitor shall be flat screen, minimum 20", 1920 x 1080 resolution, CPU to be minimum 3.0 Giga hertz operating speed, minimum 8 GB RAM with all required drivers and network cards required. Hard drive shall be 7,200 RPM with a minimum 750 GB for storage of data and trending. Provide with operating system and all required software with licenses.
 - 1. Work station location shall be coordinated with owner (may be located off site).
- E. System Software: Provide latest version of all software at Project completion. Include site licenses for all software. Include and implement the following capabilities from the control units:
 - 1. Units of Measure: Inch-pound and SI.
 - 2. WEB Based. The building system interface shall be capable of being accessed via a web based interface.
- F. Site Development Tools: Provide all site development tools including system graphics and logic programming software. Include site licenses for all software.
- G. Furnish all programming, database configuration, and complete equipment graphics and tables into a communication network and web-based graphical user interface software. Verify proper operation of system inputs, outputs, and sequences.

2.3 CONTROL PANELS

- A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.
- B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
 - 1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
 - 2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
 - 3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
 - 4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

- C. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.4 SENSORS

- A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
 - 1. Thermistor temperature sensors as follows:
 - a. Accuracy: Plus or minus 0.36 deg F at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - 2. Resistance Temperature Detectors: Platinum.
 - a. Accuracy: Plus or minus 0.2 percent at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Room Sensors: Match room thermostats, locking cover.
 - d. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 - 3. Humidity Sensors: Bulk polymer sensor element.
 - a. Accuracy: 5 percent full range with linear output.
 - b. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
 - c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
 - 4. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0 to 0.25 inch wg.
 - d. Duct Static-Pressure Range: 0 to 5 inches wg.
 - 5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

- B. Equipment operation sensors as follows:
 - 1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
 - 3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- C. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- D. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.
- E. Refrigerant Detectors: Dual-level detectors, using solid-state sensors, with alarm preset for 300 ppm, alarm indicator light, alarm silence light and button, alarm test light and button, and trouble light. Provide auxiliary relay preset for 150 ppm.
- F. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment, for flush mounting.

2.5 HUMIDISTATS

- A. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable 2 percent throttling range, 20 to 80 percent operating range, single- or double-pole contacts.
- B. Room Humidistats:
 - 1. Wall mounted, proportioning type.
 - 2. Throttling range: Adjustable 2 percent relative humidity.
 - 3. Operating range: 30 to 80 percent.
 - 4. Maximum temperature: 110 degrees F.
 - 5. Cover: Set point indication.

2.6 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
- B. Humidity Sensors:
 - 1. Elements: Accurate within 5 percent full range with linear output.
 - 2. Room Sensors: With locking cover matching pneumatic thermostats used, span of 10 to 60 percent relative humidity.

3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.

C. Static Pressure Sensors:

1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
3. Accuracy: One percent of full scale with repeatability 0.3 percent.
4. Output: 0 - 5 vdc with power at 12 to 28 vdc.

D. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

E. Digital to Pneumatic Transducers:

1. Convert plus or minus 12 vdc pulse width modulation outputs to 0 to 20 psi.

F. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

2.7 TRANSMITTERS

A. Building Static Pressure Transmitter:

1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.

B. Differential Pressure Transmitters:

1. Two pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.

C. Pressure Transmitters:

1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.

D. Temperature Transmitters:

1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degree F span and plus or minus 1 percent for 50

degree F span, with 50 degrees F temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.

E. Humidity Transmitters:

1. One pipe, directly proportioned output signal to measured variable, linearity within plus or minus 1 percent for 70 percent relative humidity span, capable of withstanding 95 percent relative humidity without loss of calibration.

PART 3 EXECUTION

3.1 HVAC CONTROLS DEMOLITION

A. Disconnect, demolish, and remove HVAC controls systems, equipment, and components indicated to be removed.

1. Piping, tubing, and conduit to Be Removed: Remove portion of piping, tubing, and conduit indicated to be removed and cap or plug that remaining with same or compatible material. Demolish any existing associated wall sleeves except as noted below.
2. Piping, tubing, and conduit to Be Abandoned in Place: Drain piping, tubing, and conduit and cap or plug same with compatible material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
6. Whenever piping, ductwork, equipment, and appurtenances are indicated to be removed, resulting in a hole, opening, void, or other discontinuity in the adjacent architectural features, these features shall be infilled and restored to a continuous appearance and function as indicated or to match existing materials of construction. Waterproofing is to be repaired, where it existed before, or where indicated. If the resulting hole is indicated to be reused, any required wall sleeve shall be replaced unless in excellent condition.
7. Do not abandon in place any unused components.

B. If pipe, tubing, conduit, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

C. Disconnect, demolish, and remove Work specified in Division 22 and 23 Drawings and Sections.

D. If pipe, tubing, conduit, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

- E. Accessible Work: Remove indicated exposed pipe, tubing, conduit in its entirety.
- F. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- G. Removal: Remove indicated equipment from Project site.
- H. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.2 ARANGEMENT OF WORK

- A. Install work as closely as possible to layouts shown on contract drawings. Modify work as necessary to provide maximum possible headroom and space clearance on each side, and as found necessary during the course of preparing coordination drawings. Provide adequate clearance and ready access to all parts of the work, for inspection operation, safe maintenance and repair, and code conformance. Coordinate and arrange work to avoid conflicts with other trades and as needed for satisfactory space conditions shown on coordination drawing submittals. Where space appears to be inadequate consult Design Professional before proceeding with installation.

3.3 COORDINATION

- A. Examine Contract Documents and coordinate with contractor and other trades as necessary to facilitate the progress of work.
- B. Furnish services of experienced electrical superintendent who shall be constantly in charge of electrical work, together with skilled laborers required to unload, transfer, erect, connect, adjust, start, operate, and test each system.
- C. Do not install a system until critical components of systems and related systems have been coordinated and applicable shop drawings have been approved.

3.4 PROTECTION

- A. The Controls Contractor shall be responsible for work and equipment until fully inspected, tested and accepted. Carefully store materials and equipment, which is not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material or damaging water.

3.5 LUBRICATION

- A. Equipment shall be furnished and installed so that lubrication points are conveniently and readily accessible for maintenance. Make these provisions by whatever means is appropriate: extended fittings, access doors, equipment location, etc. Provide lube sites for grease fittings.

3.6 TESTING AND BALANCING

- A. Provide controls systems operations during the mechanical systems adjustment period at the completion of each phase of the project, and during the final testing and balancing procedures. Document all issues encountered during the mechanical systems adjustment period. Submit three copies of issues to Owner's Construction Supervisor.

3.7 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.

3.8 INSTALLATION

- A. Install equipment level and plumb.
- B. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.
- D. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Coordinate location with owner.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- E. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated.
- F. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- H. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- I. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- J. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- K. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

- L. Sleeve conduits passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. Comply with sleeve requirements of Articles 2.07 and 3.02.M of Division 23 Section "Mechanical General Provisions" (requirements therein for pipe shall apply to Division 25 conduits.)

3.9 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Controls contractor shall be responsible for all costs for controls wiring and conduit to include providing necessary power and data to the mechanical control system components.
- B. All controls conductors shall be installed in conduit.
 - 1. Minimum conduit size shall be ½" EMT.
- C. Install raceways, boxes, and cabinets according to Division 26 Sections "Conduit for Electrical Systems" and "Boxes for Electrical Systems."
- D. Install building wire and cable according to Division 26 Section "Wiring Connections."
 - 1. Install controls conductors in minimum ½" EMT
 - 2. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
- E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.10 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to machine to allow service and maintenance.
- B. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.11 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 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 unit operation. Remove malfunctioning units, replace with new units, and retest.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
 5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
 6. Calibration test pneumatic and electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Replace damaged or malfunctioning controls and equipment.
1. Start, test, and adjust control systems.
 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- C. Verify DDC as follows:
1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 2. Verify operation of operator workstation.
 3. Verify local control units including self-diagnostics.
- 3.12 COMMISSIONING
- A. Refer to notes on mechanical drawings regarding commissioning requirements.
- B. Commissioning work shall include any work needed to the system graphics.
- 3.13 DECOMMISSION
- A. Decommission the existing controls system as it pertains to the mechanical demolition project scope. As appropriate, this shall include hiring the existing controls contractor to properly decommission the following:
1. Graphics
 2. Trending
 3. Network dependencies (data being passed in/out of space to AHU's and water systems.)
 4. Network topology (any devices the network is expecting to poll in the area.)

5. Hardware.
6. Modifying any system requiring values from the existing system to respond correctly in their absence.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours of dedicated instructor time on-site.
 3. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
 4. Schedule training with Owner, through Architect, with at least seven days advance notice.

3.15 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION

SECTION 260500 - ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. General information regarding construction.

1.3 DEFINITIONS

- A. The use of the word "Provide": Whenever the word "Provide" is used in the specifications and/or on the drawings, it shall mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated.
- B. The use of the word "Piping": "Piping" shall include but not be limited to, in addition to piping or mains, all fittings, flanges, unions, valves, strainers, drains, traps, insulation, vents, hangers and other accessories relative to such piping.
- C. The use of the word "Material": Whenever the word material is used in the specifications and/or on the drawings, it shall mean any "product", "equipment", "device", "assembly", or "item" required under the contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- D. The term "Electrical Contractor" or "Contractor" refer to the Sub Contractor or his Sub Contractors responsible for the furnishing and installation of all work indicated on the Electrical drawings and in the Electrical Specifications.
- E. The term "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, conduit, etc to gain access. "accessible ceiling" indicates acoustical tile type hung ceilings. Concealed spline or sheetrock ceilings with access panes shall not be considered accessible ceilings.

1.4 CODES, STANDARDS, REFERENCES, AND PERMITS

- A. All material and workmanship shall comply with all the latest editions of all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations.
- B. In case of differences between the Building Codes, State Law, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the contractor shall promptly notify the Engineer in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall

govern for budgetary and bid purposes. However, no work will proceed until the Engineer determines the correct method of installation.

- D. Should the contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, the contractor shall bear all costs arising in correcting the deficiencies, as approved by the Engineer.

1.5 SUBMITTALS

- A. Shop Drawings: Dimensioned plans and sections or elevation layouts of electrical equipment and devices. All clearance requirements for electrical equipment shall be included.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Provide factory representation for supervision of equipment installation and commissioning (start-up) where requested by drawings and/or specifications. The factory representative shall provide approval of adequate installation completion.
- C. Provide documentation that structural supports for stacking transformers is adequate to accommodate weights.

1.6 QUALITY ASSURANCE

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

1.7 SYSTEM DESCRIPTION

- A. Furnish and install all materials in order to provide functioning systems, upon completion, in compliance with all applicable codes, authorities having jurisdiction, manufacturer's requirements, performance requirements specified, and any modifications resulting from reviewed shop drawings and the field coordination drawings.

1.8 SCOPE OF WORK

- A. The contractor is responsible for furnishing and installing all the devices and equipment shown indicated the Electrical Drawings including materials and equipment required to create fully operational systems.
- B. The contractor shall be responsible for reviewing the Architectural, Mechanical, Plumbing, Site, Structural and Fire Protection Plans. In addition to all mechanical equipment, light fixtures fixtures, and devices indicated on the Electrical Plans, the contractor is responsible for electrical installation of all the equipment and devices shown on all Plans.
- C. Prior to bid, the contractor shall notify the Engineer of any discrepancies between the Architectural, Electrical, Mechanical, Plumbing, Site, Structural and Fire Protection Plans regarding equipment locations, equipment quantities, conduit routing, device locations, light

locations, chase locations, etc. otherwise it will be assumed the contractor is responsible for the electrical installation of all the equipment and devices shown on all Plans regardless of whether they are indicated on the Electrical Plans.

1.9 DRAWING INTERPRETATION

- A. The project drawings are schematic in nature and indicate general arrangement of equipment. It is not the intent of the drawings to substitute for shop drawings. In many instances, equipment and devices are sized on one manufacturers product. In the event of a field verification or coordination issue, report issue to Owners construction supervisor.
- B. Install work as closely as possible to layouts shown on drawings. Modify work as necessary to meet job conditions and to clear other equipment. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines, to avoid existing field conditions as well as to maintain clearances to equipment whether or not indicated on the drawings. The contractor shall provide all pull boxes and accessories as required for his work to effect these offsets, transitions and changes in direction. Consult Design Professional before making changes that effect the function or appearance of systems.
- C. Do not install equipment, devices or conduit in a non-code compliant fashion due to drawing interpretation. Provide modification of illustrated work in order to accommodate job conditions at no cost to Owner.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver conduit with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored conduit and equipment from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect electrical specialties from moisture and dirt.
- D. Store plastic conduit protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.
- G. Coordinate all electrical scope work associated with Division 26, 27 and 28 with all other divisions.
- H. Coordinate supporting electrical equipment and devices with all other divisions.
- I. Coordinate mounting heights of all devices with architectural details and shop drawings.
- 1.12 SEQUENCING AND SCHEDULING
- A. Coordinate electrical equipment installation with other building components.
- B. Arrange for conduit spaces, chases, slots, and openings in building structure during progress of construction to allow for electrical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if electrical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.13 "AS-BUILT" RECORD DRAWINGS

- A. Record daily progress on one set of construction documents. Utilize a permanent black or blue marking media. All progress of record drawings shall be provided in a neat and accurate fashion.
- B. As-built drawing reviews will be completed on a monthly basis by the engineer of record. Release of requisitions will be based on the regular progress of As-built drawings. The latest As-built drawings shall be submitted for review with each requisition for payment.
- C. Formal As-built drawings shall be submitted at completion of project. The as-built drawings shall be 1/4" scale and created in electronic format utilizing AUTOCAD 2010. At the completion of each phase of work, the electrical contractor shall submit to the Engineer the original field progress as-built drawings, the electronic files of the formal as-built drawings, and four sets of final as-built drawings plotted on same sized sheets and construction documents. Final payment for the phase of work and the start of the next phase shall be dependant of approval of the as-built drawings.

1.14 GUARANTEE

- A. Provide written guarantee of all completed/installed work. Materials, equipment and workmanship shall be guaranteed for a minimum period of one year after Owners acceptance of work. Any failure due to defective material, equipment or workmanship shall be corrected at no additional cost to owner. This shall include damage completed to other areas of construction or facility resulting from this failure. Provide correction of any failure within an acceptable/reasonable time period.
- B. Provide all equipment and material manufacturers guarantees and/or warranties to owner after acceptance of installation.

1.15 OPERATING AND MAINTENANCE MANUALS

- A. Provide operating and maintenance information for all equipment, devices, systems, and materials. This shall include all maintenance and operations procedures, recommendations, and service requirements. All submitted data must include minimum equipment/device operations and maintenance requirements to fulfill manufacturers warranties.
- B. Submit all engineering selection and specification documentation with operating and maintenance information for all equipment, devices, systems, and materials.
- C. Submit all data media in a detailed, organized, and complete manner. Provide a minimum of three copies to Owners construction supervisor for engineer/architect review. Submit in 3 ring bound enclosure.

PART 2 PRODUCTS

- 2.1 Not applicable.

PART 3 EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.
- E. Mounting heights indicated on drawings are to be measured from the center of the device to the finished floor elevation. Submit a request for unidentified mounting heights of equipment to Owners construction supervisor.
- F. Coordinate all device mounting heights with Architectural documents and ADA requirements. If discrepancy is detected, contact design professional so as to limit delay to construction.
- G. The mounting heights indicated on architectural details and shop drawings take precedence over mounting heights indicated on drawings. In the event of a mounting issue, consult Owners construction supervisor.

3.2 TEMPORARY POWER

- A. Electrical contractor shall provide all temporary power needs for the project.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.4 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.5 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Concrete bases.
 - 5. Electrical demolition.
 - 6. Cutting and patching for electrical construction.
 - 7. Touchup painting.

3.6 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 260505 - ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Report discrepancies to Architect before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.

3. Make notifications at least 24 hours in advance.
 4. Make temporary connections to maintain service in areas adjacent to work area.
 5. Coordinate work with Fire Station to transfer fire alarm system off Library.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
1. Notify Owner at least 24 hours before partially or completely disabling system.
 2. Notify telephone utility company at least 24 hours before partially or completely disabling system.
 3. Make temporary connections to maintain service in areas adjacent to work area.
 4. Coordinate work with Fire Station to transfer telecom service off Library.
- G. Existing public address and security System: Maintain existing system in service until all work is complete. Disable system only to make switchovers and connections. Minimize outage duration.
1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 2. Make temporary connections to maintain service in areas adjacent to work area.
- 3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
- A. Remove, relocate, and extend existing installations to accommodate new construction.
 - B. Remove abandoned wiring to source of supply.
 - C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 - D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
 - E. Disconnect and remove abandoned panelboards and distribution equipment.
 - F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
 - G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
 - H. Repair adjacent construction and finishes damaged during demolition and extension work.

- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Armored cable.
- C. Metal-clad cable.
- D. Wiring connectors.
- E. Electrical tape.
- F. Heat shrink tubing.
- G. Oxide inhibiting compound.
- H. Wire pulling lubricant.
- I. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 078410 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 260505 - ELECTRICAL DEMOLITION: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Additional requirements for grounding conductors and grounding connectors.
- D. Section 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.
- E. Section 262100 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE: Additional requirements for electrical service conductors.
- F. Section 284600 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2015).
- F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2016.
- G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- I. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification; Revision A, 2008.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- K. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.
- L. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
- M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.
- N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- Q. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- R. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- S. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- T. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- U. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- V. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When

installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed above accessible ceilings and in walls for branch circuits.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet or device to panelboard.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Unless approved by Owner.
 - b. Where not approved for use by the authority having jurisdiction.
 - c. Where exposed to view, except in dedicated electrical, communications, and mechanical rooms where not subject to damage.
 - d. Where exposed to damage.
 - e. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.

- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 260526.
- H. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- I. Conductor Material:
 - 1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
 - a. Substitution of aluminum conductors for copper is permitted, when approved by Owner and authority having jurisdiction, only for the following:
 - 1) Services: Copper conductors size 1/0 AWG and larger.
 - 2) Feeders: Copper conductors size #3 or higher.
 - 3) Where not specifically indicated to use copper only..
 - b. Where aluminum conductors are substituted for copper, comply with the following:
 - 1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
 - 2) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors.
 - 3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
 - 4) Equip electrical distribution equipment with compression lugs for terminating aluminum conductors.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
 - 4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

J. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.

a. Exceptions:

- 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
- 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
- 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.

2. Control Circuits: 14 AWG.

K. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

L. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.

3. Color Code:

a. 480Y/277 V, 3 Phase, 4 Wire System:

- 1) Phase A: Brown.
- 2) Phase B: Orange.
- 3) Phase C: Yellow.
- 4) Neutral/Grounded: Gray.

b. 208Y/120 V, 3 Phase, 4 Wire System:

- 1) Phase A: Black.
- 2) Phase B: Red.
- 3) Phase C: Blue.
- 4) Neutral/Grounded: White.

c. Equipment Ground, All Systems: Green.

d. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:

1. Feeders and Branch Circuits:

- a. Size 10 AWG and Smaller: Stranded.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
 - C. Insulation Voltage Rating: 600 V.
 - D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2 or THHN/THWN-2.
 - b. Installed Underground: Type XHHW-2.
 - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.
 - 2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.
- 2.4 METAL-CLAD CABLE
- A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
 - B. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Stranded.
 - 2. Size 8 AWG and Larger: Stranded.
 - C. Insulation Voltage Rating: 600 V.
 - D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
 - E. Grounding: Full-size integral equipment grounding conductor.
 - F. Armor: Steel, interlocked tape.
 - G. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.
- 2.5 WIRING CONNECTORS
- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
 - B. Connectors for Grounding and Bonding: Comply with Section 260526.

C. Wiring Connectors for Splices and Taps:

1. Copper Conductors : Use mechanical connectors or compression connectors.
2. Connectors for Aluminum Conductors: Use compression connectors or mechanical connectors.

D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Aluminum Conductors: Use compression connectors or mechanical connectors for all connections.
7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
8. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Mechanical Connectors: Provide bolted type or set-screw type.

H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.6 WIRING ACCESSORIES

A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.

2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 5. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated without specific routing, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install aluminum conductors in accordance with NECA 104.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Exposed Cable Installation (only where specifically permitted):

1. Route cables parallel or perpendicular to building structural members and surfaces.
2. Protect cables from physical damage.

- H. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- I. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- J. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- K. Install conductors with a minimum of 12 inches of slack at each outlet.
- L. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- O. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 - 5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
 - 6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- Q. Insulate ends of spare conductors using vinyl insulating electrical tape.
- R. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- S. Identify conductors and cables in accordance with Section 260553.
- T. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- U. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- 3.4 FIELD QUALITY CONTROL
- A. See Section 014000 - Quality Requirements, for additional requirements.
 - B. Perform inspection, testing, and adjusting in accordance with Section .
 - C. Inspect and test in accordance with NETA ATS, except Section 4.
 - D. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
 - E. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

1.2 RELATED REQUIREMENTS

- A. Section 096500 - Resilient Flooring: Static control flooring.
- B. Section 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- C. Section 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
- D. Section 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Shop Drawings:
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Field quality control test reports.
- F. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Rod Electrode(s):
 - a. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - b. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.

6. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- F. Service-Supplied System Grounding:
 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.
 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- H. Separately Derived System Grounding:
 1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived

system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

I. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. For new circuits, provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.

J. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
3. Refer to section 27 0526 - Grounding and Bonding for Communications Systems.

K. Cable Tray Systems: Also comply with Section 260536.

L. Static Control Flooring: Provide bonding of static control flooring provided in accordance with Section 096500.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.

3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

F. Oxide Inhibiting Compound: Comply with Section 260519.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 12 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Perform inspection, testing, and adjusting in accordance with Section 39.
- C. Inspect and test in accordance with NETA ATS except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.13.
- E. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- F. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260533.13 - CONDUIT: Additional support and attachment requirements for conduits.
- C. Section 260533.16 - BOXES: Additional support and attachment requirements for boxes.
- D. Section 265100 - INTERIOR LIGHTING: Additional support and attachment requirements for interior luminaires.
- E. Section 265600 - EXTERIOR LIGHTING: Additional support and attachment requirements for exterior luminaires.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2009.
- F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2006
- G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2010
- H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2009.
- I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

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3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
 3. In exposed locations, do not provide clamps or bolts that protrude from conduit into room.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
 2. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - d. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.

- e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Busway Supports: 1/2 inch diameter.
 - c. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
 - d. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - f. Outlet Boxes: 1/4 inch diameter.
 - g. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood: Use wood screws.
 - 9. Powder-actuated fasteners are not permitted.
 - 10. Hammer-driven anchors and fasteners are not permitted.
 - 11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
 - 12. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 13. Manufacturers - Mechanical Anchors:

- a. Hilti, Inc: www.us.hilti.com/#sle.
- b. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.

2.2 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized.
- C. Anchors and Fasteners:
 - 1. Do not use powder-actuated anchors.
- D. Fastener Types:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 6. Other Types: As required.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: Also comply with Section 260533.13.
- J. Box Support and Attachment: Also comply with Section 260533.16.
- K. Interior Luminaire Support and Attachment: Also comply with Section 265100.
- L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners according to manufacturer's recommended torque settings.
- N. Remove temporary supports.
- O. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.
- P. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
 - 1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- Q. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- R. Install surface-mounted cabinets and panelboards with minimum of four anchors.

- S. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- T. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 260533.13 - CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Electrical nonmetallic tubing (ENT).
- H. Liquidtight flexible nonmetallic conduit (LFNC).
- I. Conduit fittings.
- J. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 078410 - Penetration Firestopping: Through-penetration firestop systems.
- C. Section 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- D. Section 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- E. Section 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
- F. Section 260533.23 - Surface Raceways for Electrical Systems.
- G. Section 260533.16 - BOXES.
- H. Section 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.
- I. Section 262100 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE: Additional requirements for electrical service conduits.
- J. Section 262723 - Indoor Service Poles.

- K. Section 271000 - Structured Cabling: Additional requirements for communications systems conduits.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
- E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005 (R2013).
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
- J. NEMA TC 13 - Electrical Nonmetallic Tubing (ENT); 2014.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- N. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- Q. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- R. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- S. UL 1653 - Electrical Nonmetallic Tubing; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Exterior, Direct-Buried: Use rigid PVC conduit.
 - 2. Where rigid polyvinyl (PVC) conduit is provided, transition to schedule 80 PVC conduit where emerging from underground.
- D. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT) or MC cable per specification 260519.
- E. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- F. Interior, Damp or Wet Locations: Use electrical metallic tubing (EMT).
- G. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- I. Exposed, Exterior: Use schedule 40 pvc; schedule 80 pvc where exposed to physical damage.
- J. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use intermediate metal conduit (IMC) or electrical metallic tubing (EMT).
- K. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit, aluminum rigid metal conduit, reinforced thermosetting resin conduit (RTRC), or or PVC..
 - 1. Corrosive locations include, but are not limited to:
 - a. Cooling towers.
- L. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
 - 1. Maximum Length: 6 feet.
- M. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.

4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.

2.2 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Electrical Service Conduits: Also comply with Section 262100.
- C. Communications Systems Conduits: Also comply with Section 271000.
- D. Fittings for Grounding and Bonding: Also comply with Section 260526.
- E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- F. Provide products listed, classified, and labeled as suitable for the purpose intended.
- G. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 1/2 inch (16 mm) trade size.
 2. Control Circuits: 1/2 inch (16 mm) trade size.
 3. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
 4. Underground, Interior: 3/4 inch (21 mm) trade size.
 5. Underground, Exterior: 3/4 inch (21 mm) trade size.
- H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 3. Material: Use steel or malleable iron.
 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- C. PVC-Coated Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 - 3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 - 4. Material: Use steel or malleable iron.
 - 5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.5 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.7 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
4. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
5. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- B. Fittings:
 1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.9 ELECTRICAL NONMETALLIC TUBING (ENT)

- A. Description: NFPA 70, Type ENT electrical nonmetallic tubing complying with NEMA TC 13 and listed and labeled as complying with UL 1653.
- B. For use to install communication cables via walls to devices.
- C. Fittings:
 1. Manufacturer: Same as manufacturer of ENT to be connected.
 2. Use solvent-welded type fittings.
 3. Solvent-Welded Fittings: Rigid PVC fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; suitable for use with ENT.

2.10 ACCESSORIES

- A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

- C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- E. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- F. Install electrical nonmetallic tubing (ENT) in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal all conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.

- b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
- 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 - 14. Group parallel conduits in the same area together on a common rack.

H. Conduit Support:

- 1. Secure and support conduits in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
- 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
- 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
- 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
- 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.

7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
9. Use of spring steel conduit clips for support of conduits is not permitted.
10. Use of wire for support of conduits is not permitted.
11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

J. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.

7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- K. Underground Installation:
1. Provide trenching and backfilling.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches. 36 inches for electric service entrance and utility.
 3. Provide underground warning tape in accordance with Section 260553 along entire conduit length.
- L. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 033000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- M. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
- N. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- O. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 3. Where conduits penetrate coolers or freezers.

- P. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- Q. Provide grounding and bonding in accordance with Section 260526.
- R. Identify conduits in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 260533.16 - BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Wall and ceiling outlet boxes.
- H. Floor boxes.
- I. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

- A. Section 078410 - Penetration Firestopping: Through-penetration firestop systems.
- B. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- C. Section 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
- D. Section 260533.13 - CONDUIT:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- E. Section 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.
- F. Section 262726 - WIRING DEVICES:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Poke-through assemblies.
 - 4. Access floor boxes.

5. Additional requirements for locating boxes for wiring devices.

G. Section 271000 - Structured Cabling: Additional requirements for communications systems outlet boxes.

H. Section 26 2716 - Electrical Cabinets and Enclosures.

I. Section 26 2726 - Wiring Devices: Wall plates in finished areas.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. SCTE 77 - Specification for Underground Enclosure Integrity; 2013.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
 1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual locations for underground boxes/enclosures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use nonmetallic boxes where exposed rigid PVC conduit is used.
4. Use suitable concrete type boxes where flush-mounted in concrete.
5. Use suitable masonry type boxes where flush-mounted in masonry walls.
6. Use raised covers suitable for the type of wall construction and device configuration where required.
7. Use shallow boxes where required by the type of wall construction.
8. Do not use "through-wall" boxes designed for access from both sides of wall.
9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
11. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
12. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

13. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 14. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 271000.
 - c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
 15. Wall Plates: Comply with Section 262726.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Manufacturers:
 - a. Legrand.
 - b. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.

- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
- F. Floor Boxes:
 - 1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 - 2. Use cast iron or nonmetallic floor boxes within slab on grade.
 - 3. Use sheet-steel, cast iron, or nonmetallic floor boxes within slab above grade.
 - 4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
 - 5. Manufacturer: Same as manufacturer of floor box service fittings.
- G. Underground Boxes/Enclosures:
 - 1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
 - 2. Size: As indicated on drawings.
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
 - 4. Provide logo on cover to indicate type of service.
 - 5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
 - 6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Manufacturers:
 - 1) Highline Products, a subsidiary of MacLean Power Systems: www.highlineproducts.com.
 - 2) Hubbell Incorporated; Quazite Products: www.hubbellpowersystems.com/#sle.
 - 3) Oldcastle Precast, Inc: www.oldcastleprecast.com/#sle.
 - 4) Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.
 - b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify locations of floor boxes and outlets prior to rough-in.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- G. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes as required for devices installed under other sections or by others.
 - 4. Locate boxes so that wall plates do not span different building finishes.
 - 5. Locate boxes so that wall plates do not cross masonry joints.
 - 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.

9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- H. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- M. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.
- N. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Flush-mount enclosures located in concrete or paved areas.
 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- O. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- Q. Close unused box openings.
- R. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- S. Provide grounding and bonding in accordance with Section 260526.
- T. Identify boxes in accordance with Section 260553.
- U. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- V. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- W. Coordinate installation of outlet boxes for equipment connected under Section 26 2717.
- X. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- Y. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- Z. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.

- AA. Maintain headroom and present neat mechanical appearance.
- AB. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- AC. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- AD. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- AE. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- AF. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- AG. Use flush mounting outlet box in finished areas.
- AH. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- AI. Provide separate boxes for emergency power and normal power systems.
- AJ. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- AK. Locate outlet boxes so that wall plates do not span different building finishes.
- AL. Locate outlet boxes so that wall plates do not cross masonry joints.
- AM. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation.
 - 1. Provide minimum 24 inches separation in acoustic rated walls.
 - 2. Provide minimum 24 inches separation in fire rated walls.
- AN. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- AO. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- AP. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- AQ. Use adjustable steel channel fasteners for hung ceiling outlet box.
- AR. Do not fasten boxes to ceiling support wires.
- AS. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- AT. Use gang box where more than one device is mounted together. Do not use sectional box.
- AU. Use gang box with plaster ring for single device outlets.

AV. Set floor boxes level.

AW. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

AX. Identify boxes in accordance with Section 260553.

3.3 ADJUSTING

A. Adjust floor boxes flush with finish flooring material.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused box openings.

3.4 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

B. Clean exposed surfaces and restore finish.

3.5 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.
- B. Section 099123 - Interior Painting.
- C. Section 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 260573 - POWER SYSTEM STUDIES: Arc flash hazard warning labels.
- E. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- F. Section 271000 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.
- E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:

IDENTIFICATION FOR ELECTRICAL SYSTEMS

- 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
- b. Transformers:
- 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
- c. Enclosed switches, circuit breakers, and motor controllers:
- 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
- d. Busway:
- 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Provide identification at maximum intervals of 40 feet.
 - 5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.
- e. Enclosed Contactors:
- 1) Identify ampere rating.
 - 2) Identify voltage and phase.

- 3) Identify load(s) and associated circuits controlled. Include location.
- f. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.
3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
6. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
7. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
8. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
9. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
 - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 099123 and 099113.

10. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
 11. Arc Flash Hazard Warning Labels: Comply with Section 260573.
 12. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
- C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
 2. Identification for Communications Conductors and Cables: Comply with Section 271000.
 3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- D. Identification for Raceways:
1. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
 2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
 3. Use underground warning tape to identify underground raceways.
- E. Identification for Boxes:
1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, use only identification labels.
- F. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 271000.

2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

G. Identification for Luminaires:

1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.

2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - c. Other information as indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/4 inch.
 5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for emergency systems.
 - 2) Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch.
- F. Color: Black text on white background unless otherwise indicated.

2.4 UNDERGROUND WARNING TAPE

- A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
 - 1. Exception: Use foil-backed detectable type tape where required by serving utility or where directed by Owner.
- B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.5 FLOOR MARKING TAPE

- A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.6 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.
 8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 262715 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hinged cover enclosures.
- B. Cabinets.
- C. Terminal blocks.
- D. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- C. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association; 2005.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 ENCLOSURE MANUFACTURERS

- A. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
- B. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.

2.2 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, Type 1 steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.
- C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.
- D. Enclosure Finish: Manufacturer's standard enamel.

2.3 CABINETS

- A. Boxes: Galvanized steel.
- B. Backboard: Provide 3/4 inch thick plywood backboard for mounting terminal blocks. Paint matte white.
- C. Fronts: Steel, flush type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- D. Provide metal barriers to form separate compartments wiring of different systems and voltages.
- E. Keys: Provide two of each different key.

2.4 TERMINAL BLOCKS

- A. Terminal Blocks: NEMA ICS 4.
- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.5 ACCESSORIES

- A. Plastic Raceway: Plastic channel with hinged or snap-on cover.

ELECTRICAL CABINETS AND ENCLOSURES

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section 26 0529.
- C. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section
- D. Install cabinet fronts plumb.

3.2 CLEANING

- A. Clean electrical parts to remove conductive and harmful materials.
- B. Remove dirt and debris from enclosure.
- C. Clean finishes and touch up damage.

END OF SECTION

SECTION 262816.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. Section 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
- C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
 - 1. Includes requirements for the seismic qualification of equipment specified in this section.
- D. Section 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.
- E. Section 260573 - POWER SYSTEM STUDIES: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

ENCLOSED CIRCUIT BREAKERS

- K. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.
 2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 3. Identify mounting conditions required for equipment seismic qualification.
- D. Manufacturer's equipment seismic qualification certification.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

- G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Siemens Industry, Inc: www.usa.siemens.com.
- B. Eaton Corporation; _____: www.eaton.com/#sle.
- C. General Electric Company; _____: www.geindustrial.com/#sle.
- D. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- E. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.
- F. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.

- C. Seismic Qualification: Provide enclosed circuit breakers and associated components suitable for application under the seismic design criteria specified in Section 260548 where required. Include certification of compliance with submittals.
- D. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- E. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.
- F. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Provide thermal magnetic circuit breakers unless otherwise indicated.
- I. Provide electronic trip circuit breakers for circuit breaker frame sizes 250 amperes and above.
- J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- K. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- M. Provide externally operable handle with means for locking in the OFF position.
- N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

- 2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
- O. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 14,000 rms symmetrical amperes at 480 VAC.
 - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 - 1. Provide mechanical lugs unless otherwise indicated.
 - 2. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 2. Provide interchangeable trip units where indicated.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - b. Long time delay.
 - c. Short time pickup and delay.

- d. Instantaneous pickup.
- e. Ground fault pickup and delay where ground fault protection is indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- G. Provide the following circuit breaker types where indicated:
 - 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
- H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
- I. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
- J. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - 2. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
 - 3. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
 - 4. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed circuit breakers plumb.
- F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.
- K. Set field-adjustable ground fault protection pickup and time delay settings as directed.
- L. Identify enclosed circuit breakers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Perform inspection, testing, and adjusting in accordance with Section .
- C. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.
- G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 262816.16 - **ENCLOSED SWITCHES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. Section 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
- C. Section 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.
- D. Section 260573 - POWER SYSTEM STUDIES: Additional criteria for the selection of equipment and associated protective devices specified in this section.
- E. Section 262813 - FUSES.
- F. Section 262913 - ENCLOSED CONTROLLERS: Manual motor controllers.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

ENCLOSED SWITCHES

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Siemens Industry, Inc: www.usa.siemens.com.
- B. Eaton Corporation; _____: www.eaton.com/#sle.
- C. General Electric Company; _____: www.geindustrial.com/#sle.
- D. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- E. Substitutions: See Section 011000 General Requirements, Article 1.15 Products and Substitutions.
- F. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 260573.
 - 2. Minimum Ratings:

ENCLOSED SWITCHES

- a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
- G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- H. Provide with switch blade contact position that is visible when the cover is open.
- I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 - 1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- J. Conductor Terminations: Suitable for use with the conductors to be installed.
- K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- O. Heavy Duty Switches:
 - 1. Comply with NEMA KS 1.
 - 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
 - a. Provide means for locking handle in the ON position _____.

- P. Switch motor disconnects (such as Square D MD type) may be used for non-fused local motor disconnects provided they meet fault current level requirements, with a minimum of 10,000 AIC at 208 volts and 14,000 AIC at 480 volts.
- Q. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Hubs: As required for environment type; sized to accept conduits to be installed.
 - 2. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Perform field inspection, testing, and adjusting in accordance with Section .
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- E. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

Exhibit B

CITY OF BURLINGTON

200 CHURCH STREET HVAC UPGRADES

200 CHURCH STREET

BURLINGTON, VERMONT

INDEX OF DRAWINGS

GENERAL TRADES

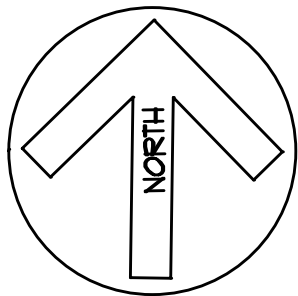
G0.01	BASEMENT GENERAL TRADES PLAN
G0.11	FIRST FLOOR GENERAL TRADES PLAN
G0.21	SECOND FLOOR GENERAL TRADES PLAN
G0.31	ROOF LEVEL GENERAL TRADES PLAN

MECHANICAL

M0.01	BASEMENT MECHANICAL DEMOLITION PLAN
M0.11	FIRST FLOOR MECHANICAL DEMOLITION PLAN
M0.21	SECOND FLOOR MECHANICAL DEMOLITION PLAN
M0.31	ROOF LEVEL MECHANICAL DEMOLITION PLAN
M1.01	BASEMENT MECHANICAL NEW WORK PLAN
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M1.21	SECOND FLOOR MECHANICAL NEW WORK PLAN
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M2.11	FIRST FLOOR HVAC PIPING NEW WORK PLAN
M2.21	SECOND FLOOR HVAC PIPING NEW WORK PLAN
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M5.02	MECHANICAL SCHEDULES
M5.03	MECHANICAL SCHEDULES
M6.01	MECHANICAL DETAILS

ELECTRICAL

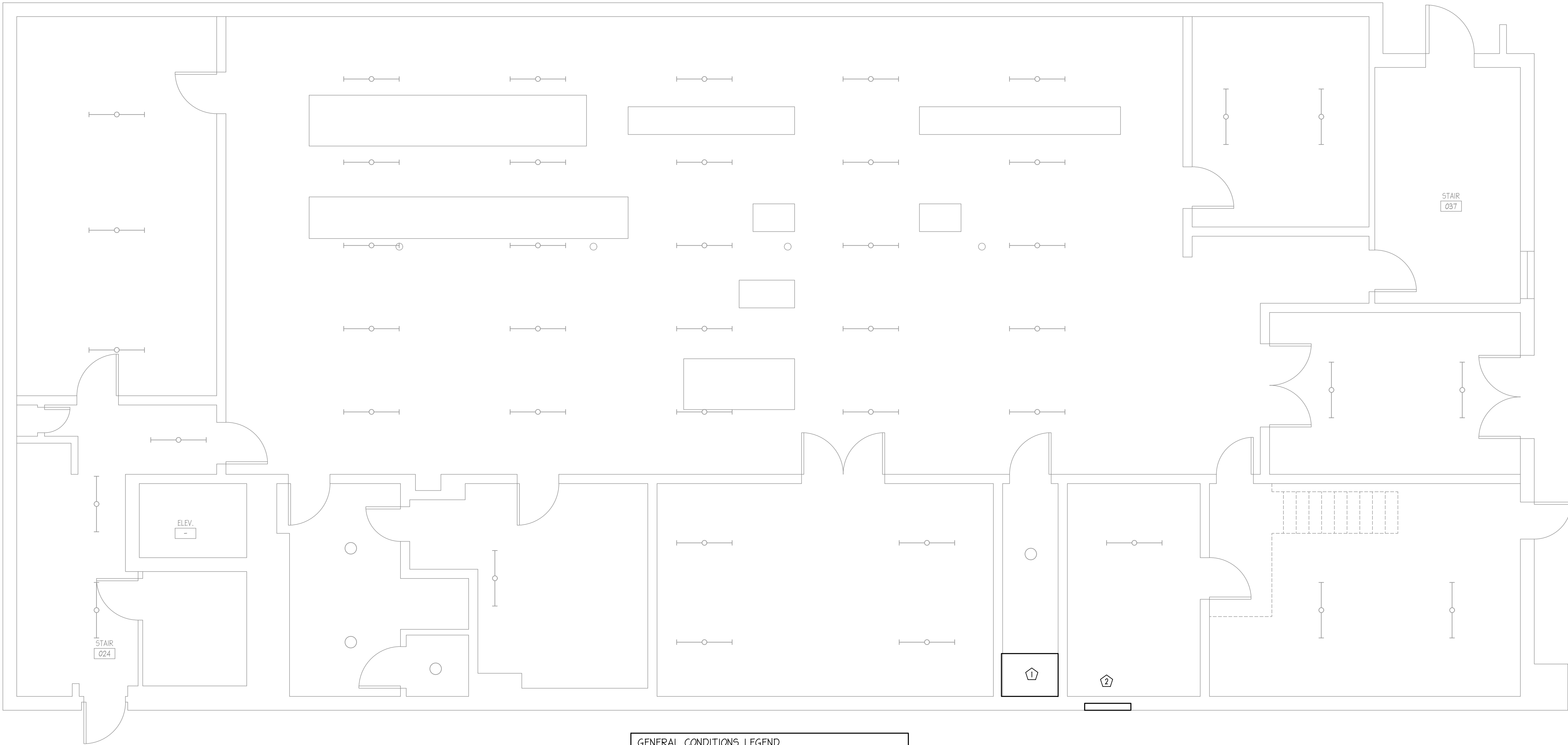
E0.01	BASEMENT ELECTRICAL DEMOLITION PLAN
E0.11	FIRST FLOOR ELECTRICAL DEMOLITION PLAN
E0.21	SECOND FLOOR ELECTRICAL DEMOLITION PLAN
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E1.31	ROOF LEVEL ELECTRICAL NEW WORK PLAN
E5.01	ELECTRICAL SCHEDULES, NOTES AND LEGENDS



ISSUED FOR BIDDING

August 17, 2022





GENERAL CONDITIONS LEGEND	
----	EXISTING TO BE DEMOLISHED
—	PROPOSED TO BE FURNISHED AND INSTALLED
—	EXISTING TO REMAIN

GENERAL NOTES:

1. PROVIDE THE SERVICES OF A GENERAL CONTRACTOR TO PERFORM THE GENERAL CONDITIONS SCOPE OF WORK.

⬢ GENERAL CONDITIONS SPECIFIC NOTES:

1. INFILL EXISTING FLOOR PENETRATION AND PROVIDE NEW FLOORING TO MATCH EXISTING CONDITIONS.
2. INFILL EXISTING WALL PENETRATIONS WHERE MECHANICAL LOUVER AND BOILER FLUES ARE INDICATED TO BE REMOVED. PROVIDE WEATHER PROOF EXTERIOR AND MINIMUM OF R-19 INSULATION PER ENERGY EFFICIENCY CODE.
3. IN GENERAL EXISTING ACOUSTICAL CEILING GRID SYSTEM AND CEILING TILES ARE TO REMAIN EXISTING. CEILING TILES ARE TO BE REMOVED AND RELOCATED TO ACCOMMODATE GRILLE AND DIFFUSER RELOCATIONS AND TO ACCOMMODATE MECHANICAL AND ELECTRICAL INSTALLATIONS.
4. DEMOLISH EXISTING CHASE WALL BACK TO FLOOR AND CEILING. PATCH AND REPAIR FLOOR AND CEILING FINISHES TO MATCH EXISTING CONDITIONS.
5. FURNISH AND INSTALL NEW FLOOR PENETRATIONS THROUGH BUILDING FLOOR TO ACCOMMODATE PROPOSED DUCTWORK ROUTING. PROVIDE OPENING ONLY AS REQUIRED TO ACCOMMODATE DUCT PENETRATION AND PROPOSED FIRE DAMPER AT FLOOR.
6. FURNISH AND INSTALL NEW SHEETROCK AND STUD WALL ENCLOSURE TO CONCEAL PROPOSED DUCTWORK RISERS THROUGH SECOND FLOOR. PROVIDE 24"x24" ACCESS DOORS ALIGNED WITH DUCTWORK RISERS AND DUCT ACCESS DOORS.
7. IN GENERAL EXISTING SHEET ROCK CEILING SYSTEM OR SOFFIT ARE TO REMAIN EXISTING. DAMAGE TO HARD CEILING OR PENETRATIONS REQUIRED FOR ACCESS TO CONCEALED SPACES ABOVE SHALL BE REPAIRED.

8. FURNISH AND INSTALL STRUCTURAL ROOF CURB FOR EQUIPMENT SUPPORT. PROVIDE THE SERVICES OF AN OWNER APPROVED ROOFING CONTRACTOR TO PERFORM ROOF WORK TO MAINTAIN WARRANTIES.
9. INFILL EXISTING ROOF PENETRATION WHERE DUCTWORK WAS REMOVED. PROVIDE FRAMED OPENING WITHIN INFILL TO ACCOMMODATE SIZE OF PROPOSED VENTILATION AIR DUCTWORK DOWN THROUGH ROOF. INSULATE NEW ROOF TO MATCH EXISTING ROOF INSULATION THICKNESS OR MINIMUM OF R-40 WHICHEVER IS GREATER. PROVIDE THE SERVICES OF AN OWNER APPROVED ROOFING CONTRACTOR TO PERFORM ROOF WORK TO MAINTAIN WARRANTIES.
10. PROVIDE NEW ROOF PENETRATION AND PITCH POCKET FOR REFRIGERATION PIPE PENETRATIONS AND ELECTRICAL CONDUIT PENETRATIONS. FILL PITCH POCKET TO ELIMINATE LOW POINTS AND PROVIDE COMPLETE DRAINAGE. COORDINATE WORK WITH OWNER APPROVED ROOFING CONTRACTOR.
11. FURNISH AND INSTALL 6"x6" PRESSURE TREATED LUMBER WRAPPED IN ROOF MEMBRANE FOR EQUIPMENT SUPPORT. FASTEN EQUIPMENT TO SLEEPERS. PROVIDE ADDITIONAL SHEET OF ROOF MEMBRANE BETWEEN SLEEPERS AND ROOF TO PROTECT ROOF MEMBRANE.
12. DEMOLISH EXISTING ROOF TOP UNIT ROOF CURB BACK TO DECK. INFILL EXISTING DUCT PENETRATIONS BASED ON PROPOSED DUCTWORK LAYOUT. THE EXISTING PORTIONS OF THE DECK SHALL BE CLOSED UP, INSULATED AND ROOF OVER TO MATCH EXISTING CONDITIONS. ROOFING MATERIAL SHALL MATCH EXISTING. ALL ROOFING WORK TO BE COORDINATED WITH ORIGINAL INSTALLER AS REQUIRED TO MAINTAIN ANY EXISTING WARRANTIES.
13. MECHANICAL CONTRACTOR SHALL PROVIDE STRUCTURAL SHOP DRAWINGS BY STATE OF VERMONT LICENSED STRUCTURAL ENGINEER FOR ANY ROOF REINFORCEMENT REQUIRED TO ACCOMMODATE PROPOSED MECHANICAL SYSTEMS. ANY STRUCTURAL MODIFICATIONS REQUIRED TO ACCOMMODATE PROPOSED EQUIPMENT, ROOF PENETRATIONS, ETC. SHALL BE

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CONSTRUCTION



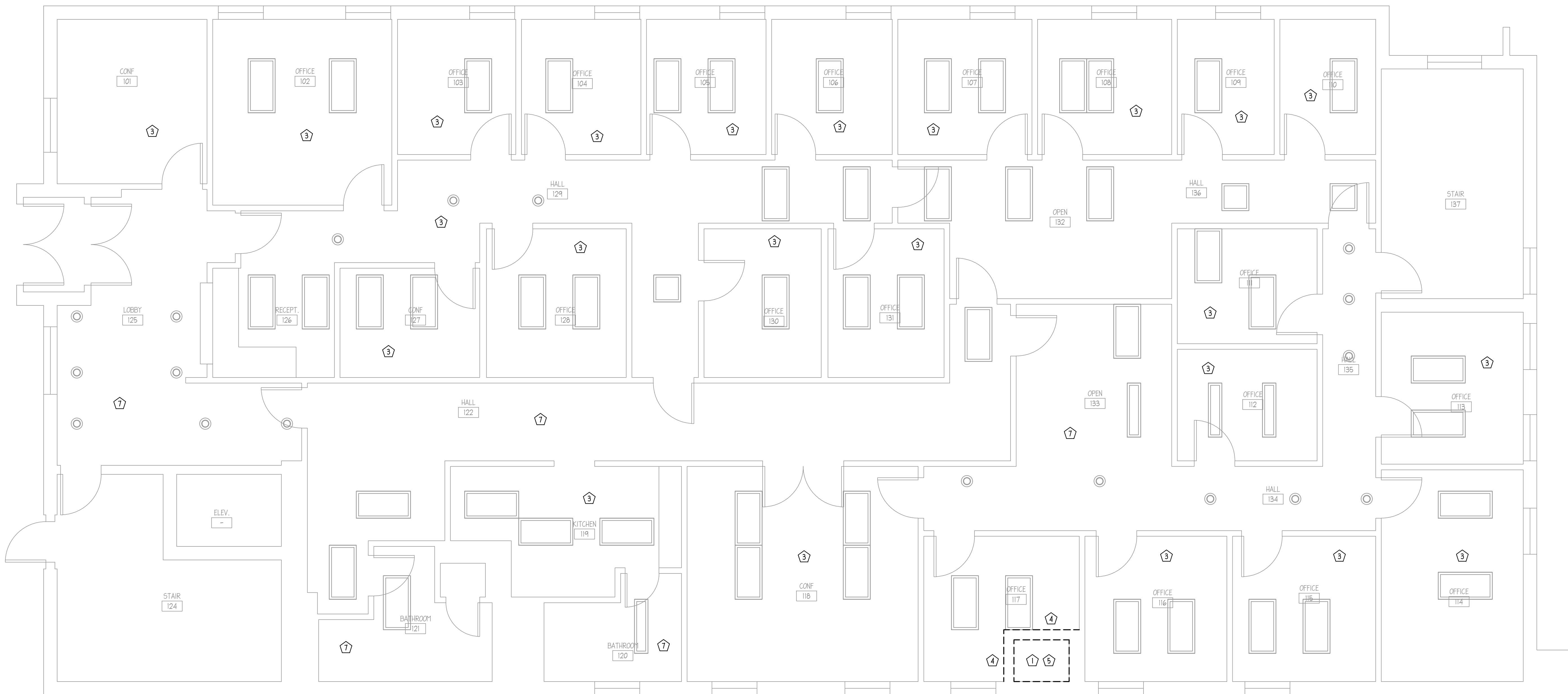
200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION

PROJECT #:	21201
DRAWN:	ARW
CHECKED:	GDM
DATE:	8/17/2022
SCALE:	1/4" = 1'-0"

BASEMENT
GENERAL TRADES
PLAN

G0.01



GENERAL CONDITIONS LEGEND	
---	EXISTING TO BE DEMOLISHED
---	PROPOSED TO BE FURNISHED AND INSTALLED
---	EXISTING TO REMAIN

GENERAL CONDITIONS SPECIFIC NOTES:

- INFILL EXISTING FLOOR PENETRATION AND PROVIDE NEW FLOORING TO MATCH EXISTING CONDITIONS.
- INFILL EXISTING WALL PENETRATIONS WHERE MECHANICAL LOUVER AND BOILER FLUES ARE INDICATED TO BE REMOVED. PROVIDE WEATHER PROOF EXTERIOR AND MINIMUM OF R-19 INSULATION PER ENERGY EFFICIENCY CODE.
- IN GENERAL EXISTING ACOUSTICAL CEILING GRID SYSTEM AND CEILING TILES ARE TO REMAIN EXISTING. CEILING TILES ARE TO BE REMOVED AND RELOCATED TO ACCOMMODATE GRILLE AND DIFFUSER RELOCATIONS AND TO ACCOMMODATE MECHANICAL AND ELECTRICAL INSTALLATIONS.
- DEMOLISH EXISTING CHASE WALL BACK TO FLOOR AND CEILING. PATCH AND REPAIR FLOOR AND CEILING FINISHES TO MATCH EXISTING CONDITIONS.
- FURNISH AND INSTALL NEW FLOOR PENETRATIONS THROUGH BUILDING FLOOR TO ACCOMMODATE PROPOSED DUCTWORK ROUTING. PROVIDE OPENING ONLY AS REQUIRED TO ACCOMMODATE DUCT PENETRATION AND PROPOSED FIRE DAMPER AT FLOOR.
- FURNISH AND INSTALL NEW SHEETROCK AND STUD WALL ENCLOSURE TO CONCEAL PROPOSED DUCTWORK RISERS THROUGH SECOND FLOOR. PROVIDE 24"x24" ACCESS DOORS ALIGNED WITH DUCTWORK RISERS AND DUCT ACCESS DOORS.
- IN GENERAL EXISTING SHEET ROCK CEILING SYSTEM OR SOFFIT ARE TO REMAIN EXISTING. DAMAGE TO HARD CEILING OR PENETRATIONS REQUIRED FOR ACCESS TO CONCEALED SPACES ABOVE SHALL BE REPAIRED.

- FURNISH AND INSTALL STRUCTURAL ROOF CURB FOR EQUIPMENT SUPPORT. PROVIDE THE SERVICES OF AN OWNER APPROVED ROOFING CONTRACTOR TO PERFORM ROOF WORK TO MAINTAIN WARRANTIES.
- INFILL EXISTING ROOF PENETRATION WHERE DUCTWORK WAS REMOVED. PROVIDE FRAMED OPENING WITHIN INFILL TO ACCOMMODATE SIZE OF PROPOSED VENTILATION AIR DUCTWORK DOWN THROUGH ROOF. INSULATE NEW ROOF TO MATCH EXISTING ROOF INSULATION THICKNESS OR MINIMUM OF R-40 WHICHEVER IS GREATER. PROVIDE THE SERVICES OF AN OWNER APPROVED ROOFING CONTRACTOR TO PERFORM ROOF WORK TO MAINTAIN WARRANTIES.
- PROVIDE NEW ROOF PENETRATION AND PITCH POCKET FOR REFRIGERATION PIPE PENETRATIONS AND ELECTRICAL CONDUIT PENETRATIONS. FILL PITCH POCKET TO ELIMINATE LOW POINTS AND PROVIDE COMPLETE DRAINAGE. COORDINATE WORK WITH OWNER APPROVED ROOFING CONTRACTOR.
- FURNISH AND INSTALL 6"x6" PRESSURE TREATED LUMBER WRAPPED IN ROOF MEMBRANE FOR EQUIPMENT SUPPORT. FASTEN EQUIPMENT TO SLEEPERS. PROVIDE ADDITIONAL SHEET OF ROOF MEMBRANE BETWEEN SLEEPERS AND ROOF TO PROTECT ROOF MEMBRANE.
- DEMOLISH EXISTING ROOF TOP UNIT ROOF CURB BACK TO DECK. INFILL EXISTING DUCT PENETRATIONS BASED ON PROPOSED DUCTWORK LAYOUT. THE EXISTING PORTIONS OF THE DECK SHALL BE CLOSED UP, INSULATED AND ROOF OVER TO MATCH EXISTING CONDITIONS. ROOFING MATERIAL SHALL MATCH EXISTING. ALL ROOFING WORK TO BE COORDINATED WITH ORIGINAL INSTALLER AS REQUIRED TO MAINTAIN ANY EXISTING WARRANTIES.
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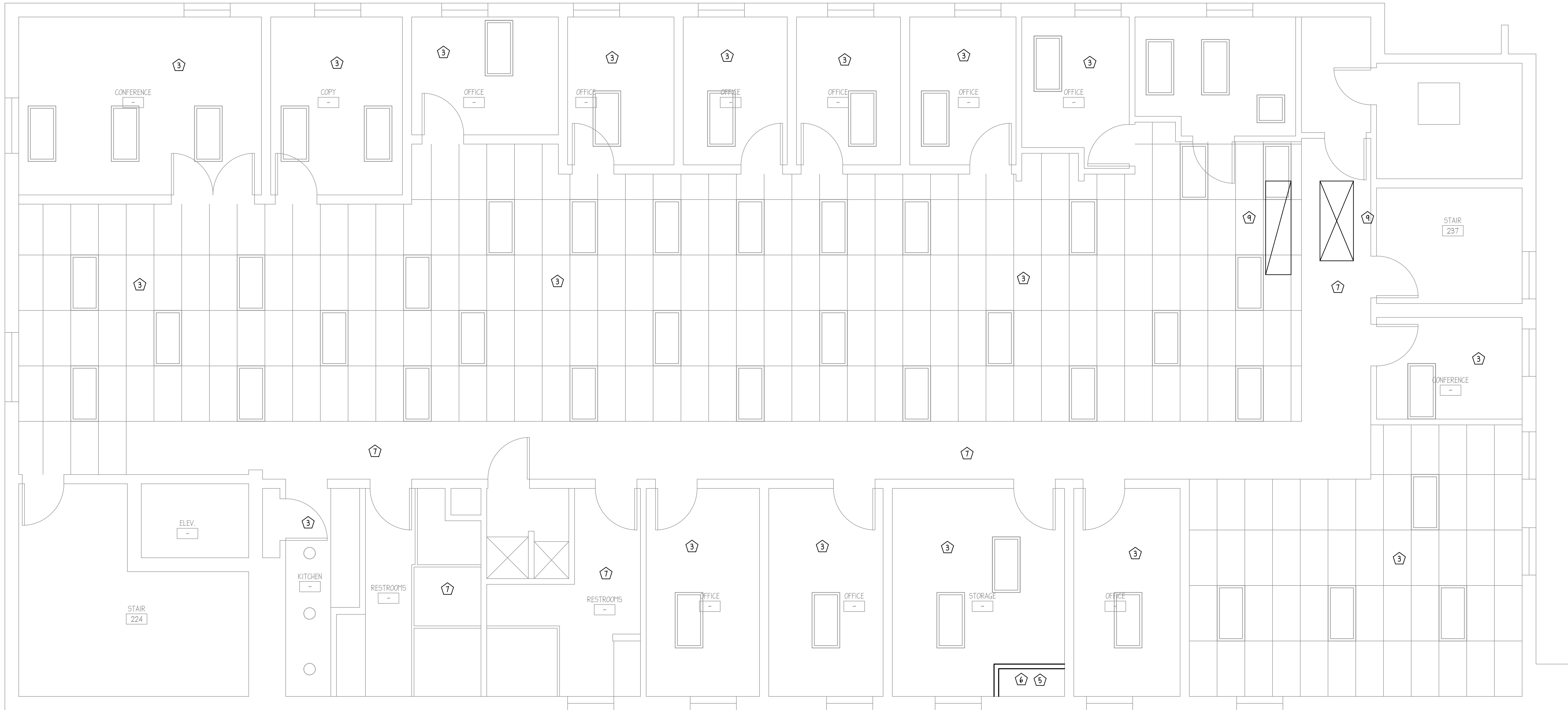


200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION
PROJECT #:	21201	
DRAWN:	ARW	
CHECKED:	GDM	
DATE:	8/17/2022	
SCALE:	1/4" = 1'-0"	

FIRST FLOOR
GENERAL TRADES
PLAN

G0.11



GENERAL CONDITIONS LEGEND	
----	EXISTING TO BE DEMOLISHED
—	PROPOSED TO BE FURNISHED AND INSTALLED
—	EXISTING TO REMAIN

GENERAL CONDITIONS SPECIFIC NOTES:

GENERAL NOTES:

1. PROVIDE THE SERVICES OF A GENERAL CONTRACTOR TO PERFORM THE GENERAL CONDITIONS SCOPE OF WORK.

- INFILL EXISTING FLOOR PENETRATION AND PROVIDE NEW FLOORING TO MATCH EXISTING CONDITIONS.
- INFILL EXISTING WALL PENETRATIONS WHERE MECHANICAL LOUVER AND BOILER FLUES ARE INDICATED TO BE REMOVED. PROVIDE WEATHER PROOF EXTERIOR AND MINIMUM OF R-19 INSULATION PER ENERGY EFFICIENCY CODE.
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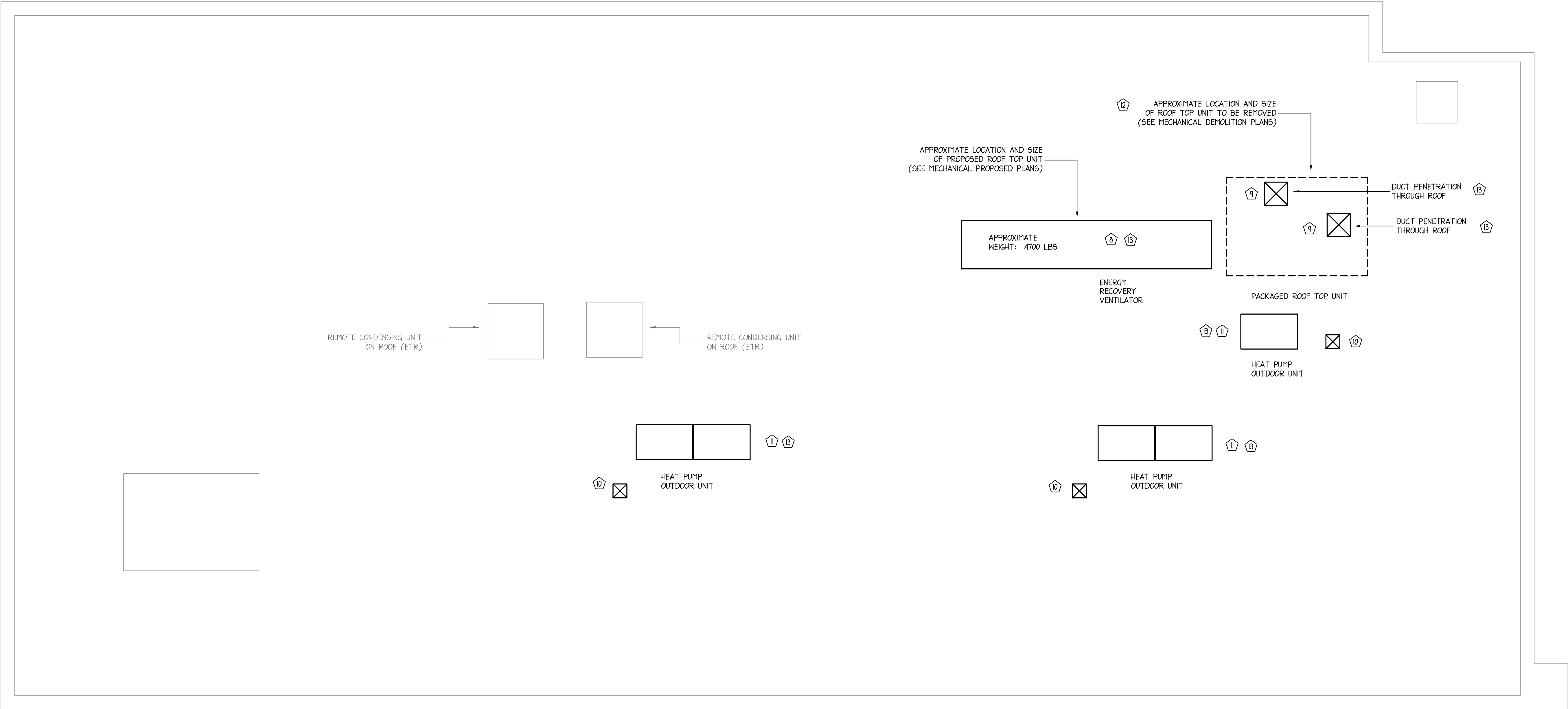
200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION

PROJECT #:	21201
DRAWN:	ARW
CHECKED:	GDM
DATE:	8/17/2022
SCALE:	1/4" = 1'-0"

SECOND FLOOR
GENERAL TRADES
PLAN

G0.21



GENERAL CONDITIONS LEGEND	
---	EXISTING TO BE DEMOLISHED
—	PROPOSED TO BE FURNISHED AND INSTALLED
—	EXISTING TO REMAIN

GENERAL CONDITIONS SPECIFIC NOTES:

GENERAL NOTES:

1. PROVIDE THE SERVICES OF A GENERAL CONTRACTOR TO PERFORM THE GENERAL CONDITIONS SCOPE OF WORK.

1. INFILL EXISTING FLOOR PENETRATION AND PROVIDE NEW FLOORING TO MATCH EXISTING CONDITIONS.
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13. MECHANICAL CONTRACTOR SHALL PROVIDE STRUCTURAL SHOP DRAWINGS BY STATE OF VERMONT LICENSED STRUCTURAL ENGINEER FOR ANY ROOF REINFORCEMENT REQUIRED TO ACCOMMODATE PROPOSED MECHANICAL SYSTEMS. ANY STRUCTURAL MODIFICATIONS REQUIRED TO ACCOMMODATE PROPOSED EQUIPMENT, ROOF PENETRATIONS, ETC. SHALL BE INCLUDED AS AN ALLOWANCE OF \$15,000.

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200 CHURCH STREET
BURLINGTON, VERMONT

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SCALE:	1/4" = 1'-0"

ROOF LEVEL
GENERAL TRADES
PLAN

G0.31



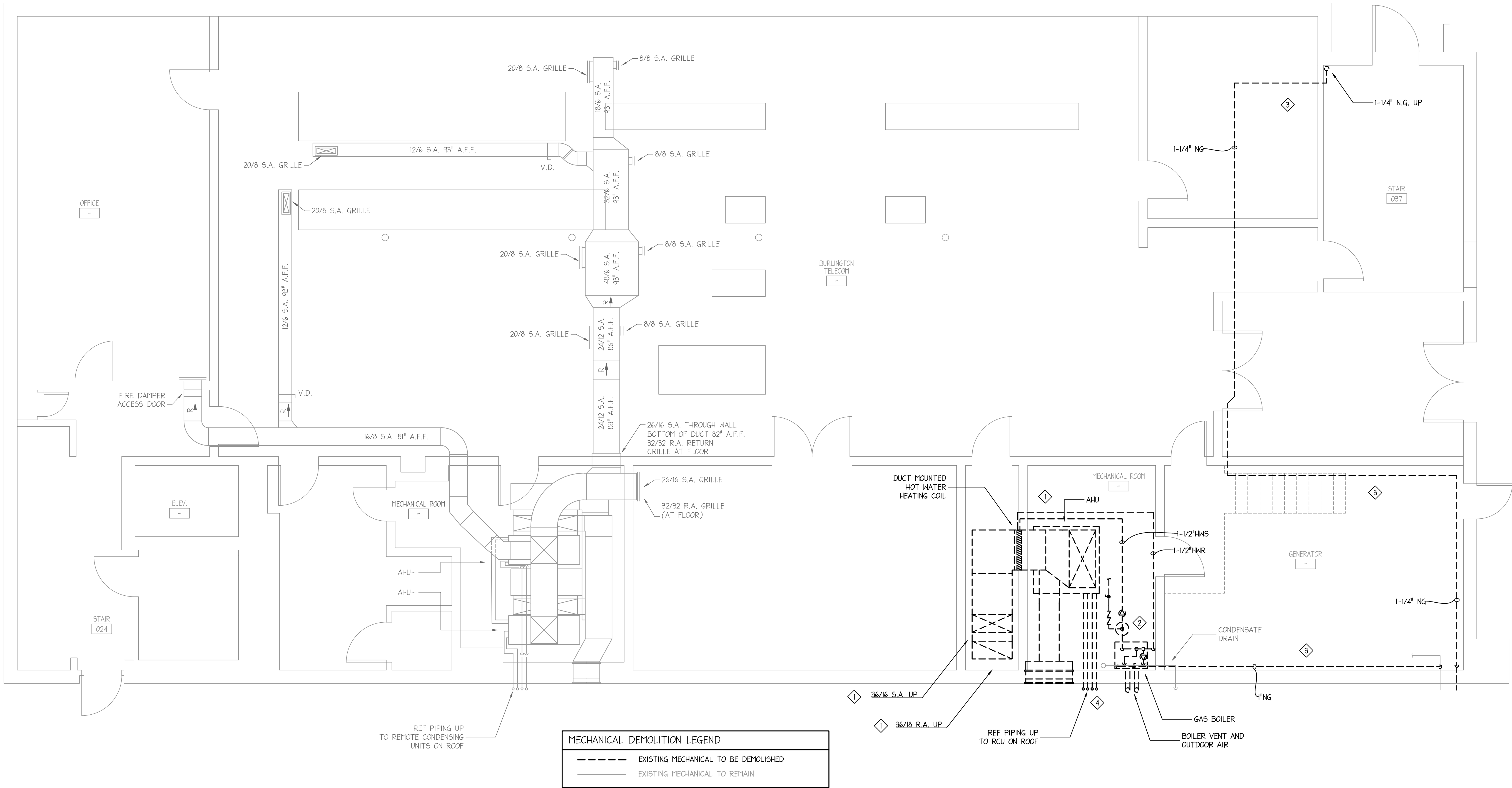
200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION

PROJECT #:	21201
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SCALE:	1/4" = 1'-0"

BASEMENT
MECHANICAL
DEMOLITION PLAN

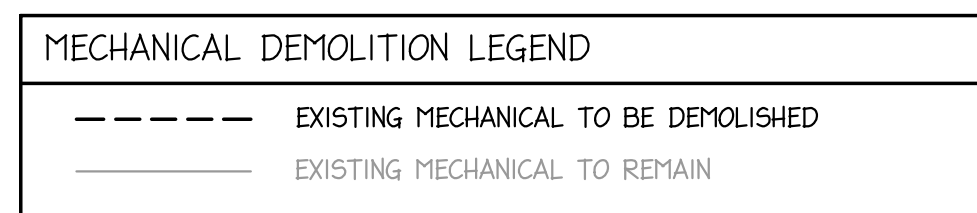
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**NOT FOR
CONSTRUCTION**



200 CHURCH STREET
BURLINGTON, VERMONT



1. DEMOLISH EXISTING AIR HANDLER, SUPPLY DUCTWORK, RETURN DUCTWORK, OUTSIDE AIR DUCTWORK AND EXTERIOR INTAKE LOUVER. DEMOLISH EXISTING DUCTWORK RISES UP TO FLOOR ABOVE.
2. DEMOLISH EXISTING HOT WATER BOILER, INTAKE AND VENT PIPES, HOT WATER SUPPLY AND RETURN PIPING, PUMPS, AND HOT WATER HEATING COIL. DEMOLISH EXISTING MAKE UP WATER SUPPLY BACK TO LAST ACTIVE BRANCH AND CAP.
3. DEMOLISH EXISTING NATURAL GAS PIPING SERVING EQUIPMENT INDICATED TO BE REMOVED. PATCH AND SEAL EXISTING FLOOR AND WALL PENETRATIONS. COORDINATE SHUTDOWNS OF THE GAS SERVICE WITH UTILITY COMPANY AND OWNER.
4. EVACUATE AND RECOVER REFRIGERANT FROM THE EXISTING REFRIGERATION SYSTEM AND RECYCLE OR DISPOSE PER EPA AND LOCAL CODES. DEMOLITION EXISTING PIPING, INSULATION, REMOTE CONDENSING UNIT AND ASSOCIATED CONTROLS.
5. IN GENERAL, SALVAGE ALL EXISTING GRILLES AND DIFFUSERS. GRILLES OR DIFFUSERS INDICATED TO BE DEMOLISHED SHALL BE REMOVED AND RELOCATED AND UTILIZED AS PART OF PROPOSED LAYOUT. SEE NEW WORK PLANS.
6. DEMOLISH EXISTING EXHAUST FAN, DUCTWORK AND EXHAUST DUCTWORK. PATCH AND SEAL EXHAUST WALL PENETRATION.
7. DEMOLISH EXISTING ROOF TOP UNIT, ROOF CURB, SUPPLY DUCTWORK AND RETURN DUCTWORK. COORDINATE REMOVAL OF EQUIPMENT CURB WITH ROOFING CONTRACTOR TO MAINTAIN WEATHER PROOF BUILDING ENVELOPE.

1. THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
2. THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

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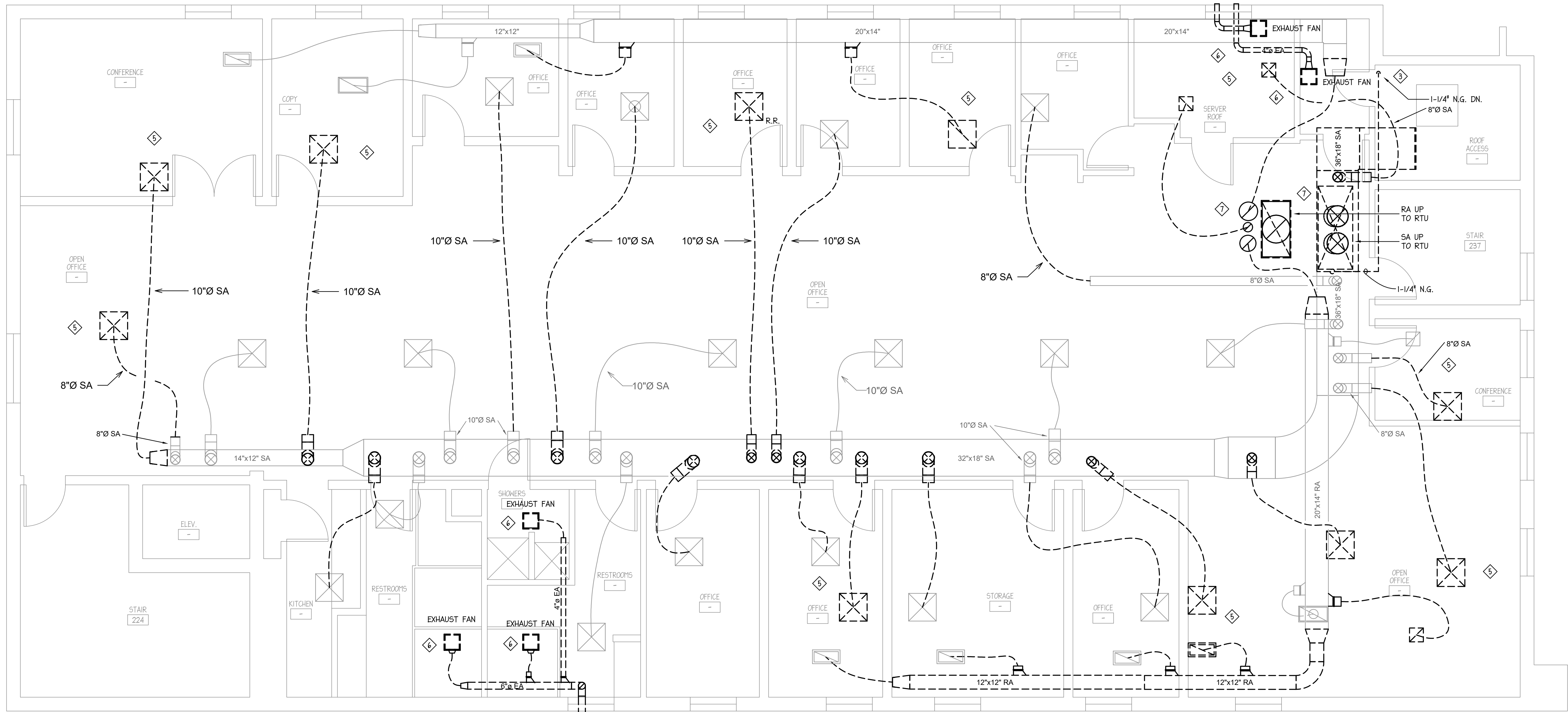
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FIRST FLOOR
MECHANICAL
DEMOLITION PLAN

MO.11



200 CHURCH STREET
BURLINGTON, VERMONT



MECHANICAL DEMOLITION LEGEND	
	EXISTING MECHANICAL TO BE DEMOLISHED
	EXISTING MECHANICAL TO REMAIN

MECHANICAL SPECIFIC DEMOLITION NOTES:

- DEMOLISH EXISTING AIR HANDLER, SUPPLY DUCTWORK, RETURN DUCTWORK, OUTSIDE AIR DUCTWORK AND EXTERIOR INTAKE LOUVER. DEMOLISH EXISTING DUCTWORK RISERS UP TO FLOOR ABOVE.
- DEMOLISH EXISTING HOT WATER BOILER, INTAKE AND VENT PIPES, HOT WATER SUPPLY AND RETURN PIPING, PUMPS, AND HOT WATER HEATING COIL. DEMOLISH EXISTING MAKE UP WATER SUPPLY BACK TO LAST ACTIVE BRANCH AND CAP.
- DEMOLISH EXISTING NATURAL GAS PIPING SERVING EQUIPMENT INDICATED TO BE REMOVED. PATCH AND SEAL EXISTING FLOOR AND WALL PENETRATIONS. COORDINATE SHUTDOWNS OF THE GAS SERVICE WITH UTILITY COMPANY AND OWNER.
- EVACUATE AND RECOVER REFRIGERANT FROM THE EXISTING REFRIGERATION SYSTEM AND RECYCLE OR DISPOSE PER EPA AND LOCAL CODES. DEMOLITION EXISTING PIPING, INSULATION, REMOTE CONDENSING UNIT AND ASSOCIATED CONTROLS.
- IN GENERAL, SALVAGE ALL EXISTING GRILLES AND DIFFUSERS. GRILLES OR DIFFUSER INDICATED TO BE DEMOLISHED SHALL BE REMOVED AND RELOCATED AND UTILIZED AS PART OF PROPOSED LAYOUT. SEE NEW WORK PLANS.
- DEMOLISH EXISTING EXHAUST FAN, DUCTWORK AND EXHAUST DUCTWORK. PATCH AND SEAL EXISTING WALL PENETRATION.
- DEMOLISH EXISTING ROOF TOP UNIT, ROOF CURB, SUPPLY DUCTWORK AND RETURN DUCTWORK. COORDINATE REMOVAL OF EQUIPMENT CURB WITH ROOFING CONTRACTOR TO MAINTAIN WEATHER PROOF BUILDING ENVELOPE.

GENERAL MECHANICAL NOTES:

- THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
- THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

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SECOND FLOOR
MECHANICAL
DEMOLITION PLAN

M0.21

ISSUED FOR
BID
NOT FOR
CONSTRUCTION



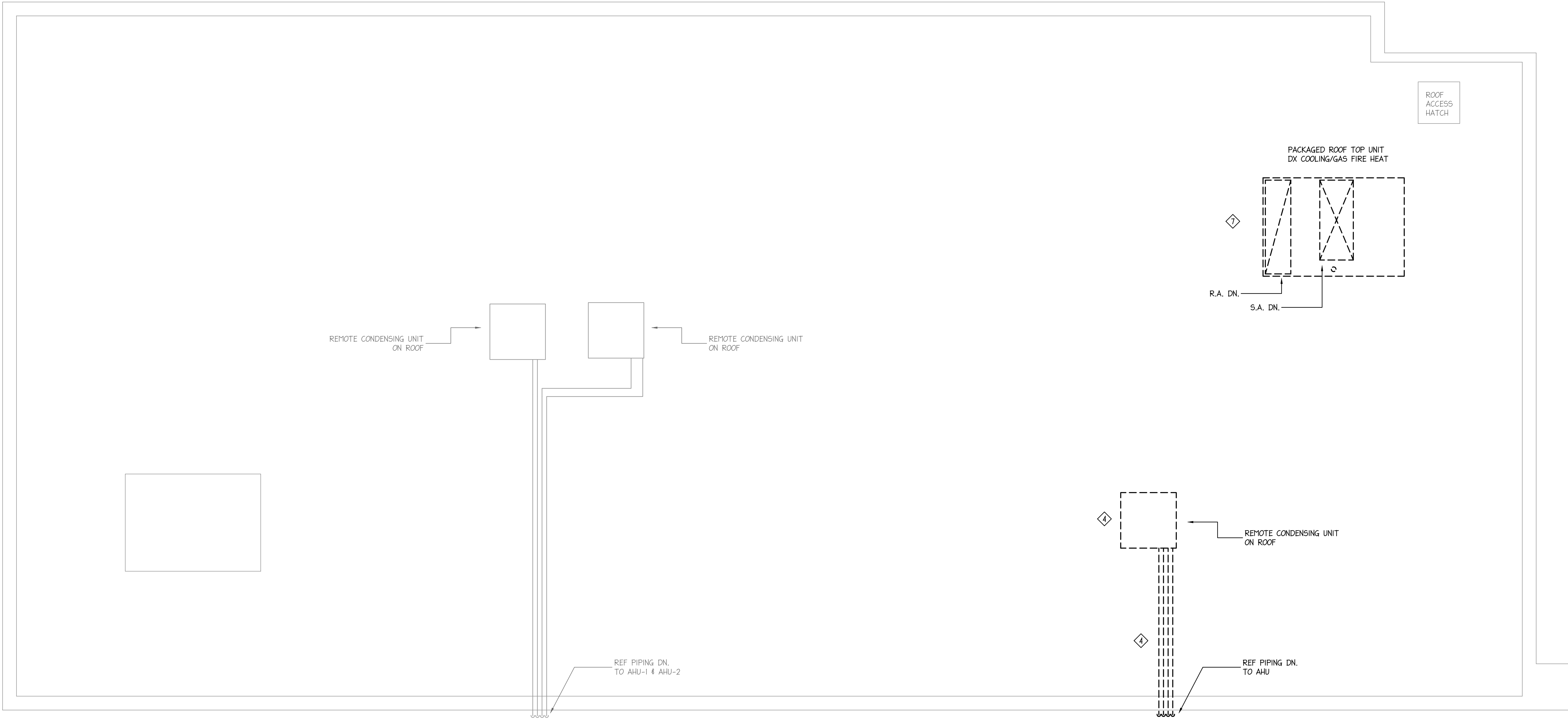
200 CHURCH STREET
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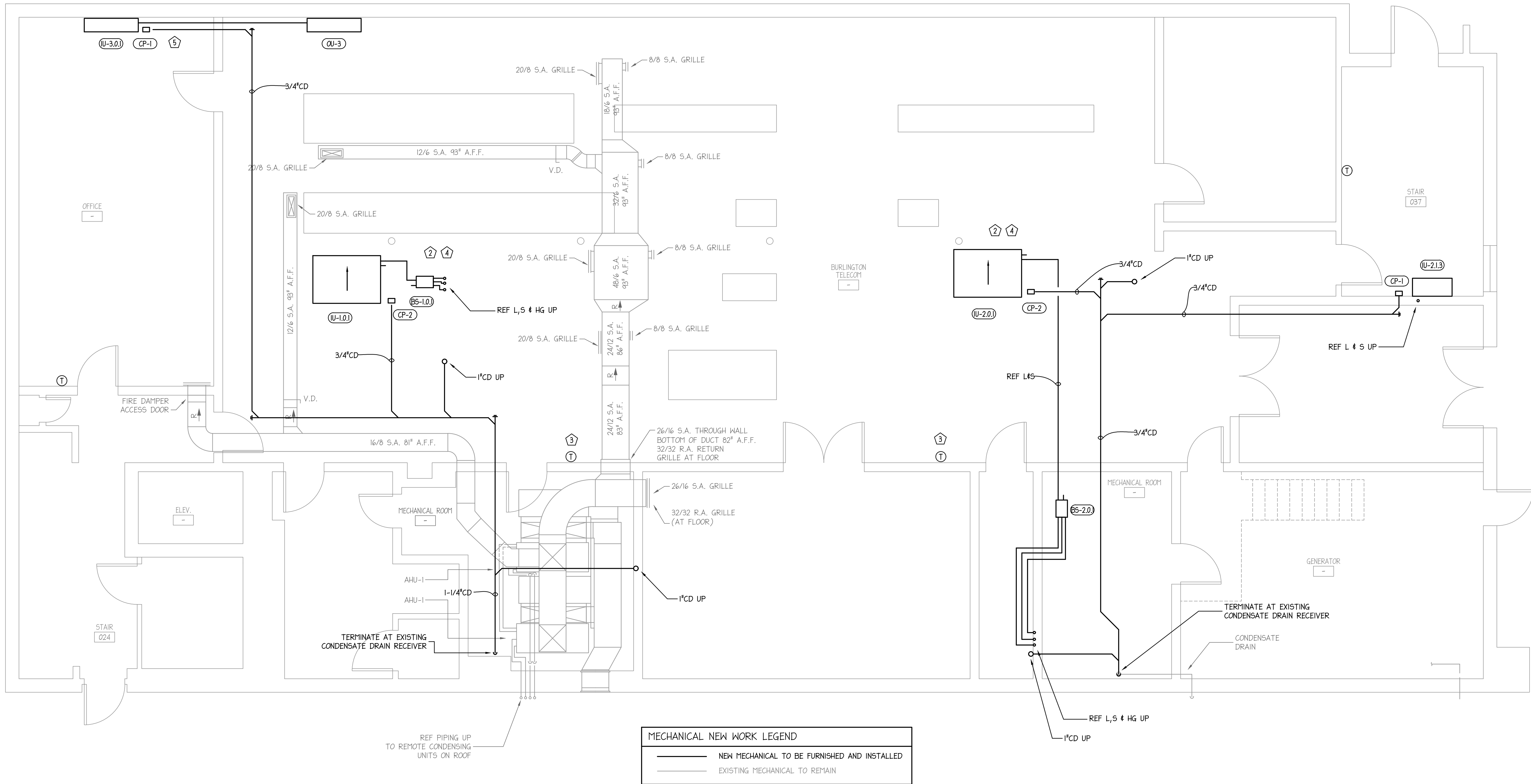
ROOF LEVEL
MECHANICAL
DEMOLITION PLAN

M0.31



MECHANICAL DEMOLITION LEGEND	
-----	EXISTING MECHANICAL TO BE DEMOLISHED
—————	EXISTING MECHANICAL TO REMAIN

- MECHANICAL SPECIFIC DEMOLITION NOTES:
- DEMOLISH EXISTING AIR HANDLER, SUPPLY DUCTWORK, RETURN DUCTWORK, OUTSIDE AIR DUCTWORK AND EXTERIOR INTAKE LOUVER. DEMOLISH EXISTING DUCTWORK RISERS UP TO FLOOR ABOVE.
 - DEMOLISH EXISTING HOT WATER BOILER, INTAKE AND VENT PIPES, HOT WATER SUPPLY AND RETURN PIPING, PUMPS, AND HOT WATER HEATING COIL. DEMOLISH EXISTING MAKE UP WATER SUPPLY BACK TO LAST ACTIVE BRANCH AND CAP.
 - DEMOLISH EXISTING NATURAL GAS PIPING SERVING EQUIPMENT INDICATED TO BE REMOVED. PATCH AND SEAL EXISTING FLOOR AND WALL PENETRATIONS. COORDINATE SHUTDOWNS OF THE GAS SERVICE WITH UTILITY COMPANY AND OWNER.
 - EVACUATE AND RECOVER REFRIGERANT FROM THE EXISTING REFRIGERATION SYSTEM AND RECYCLE OR DISPOSE PER EPA AND LOCAL CODES. DEMOLITION EXISTING PIPING, INSULATION, REMOTE CONDENSING UNIT AND ASSOCIATED CONTROLS.
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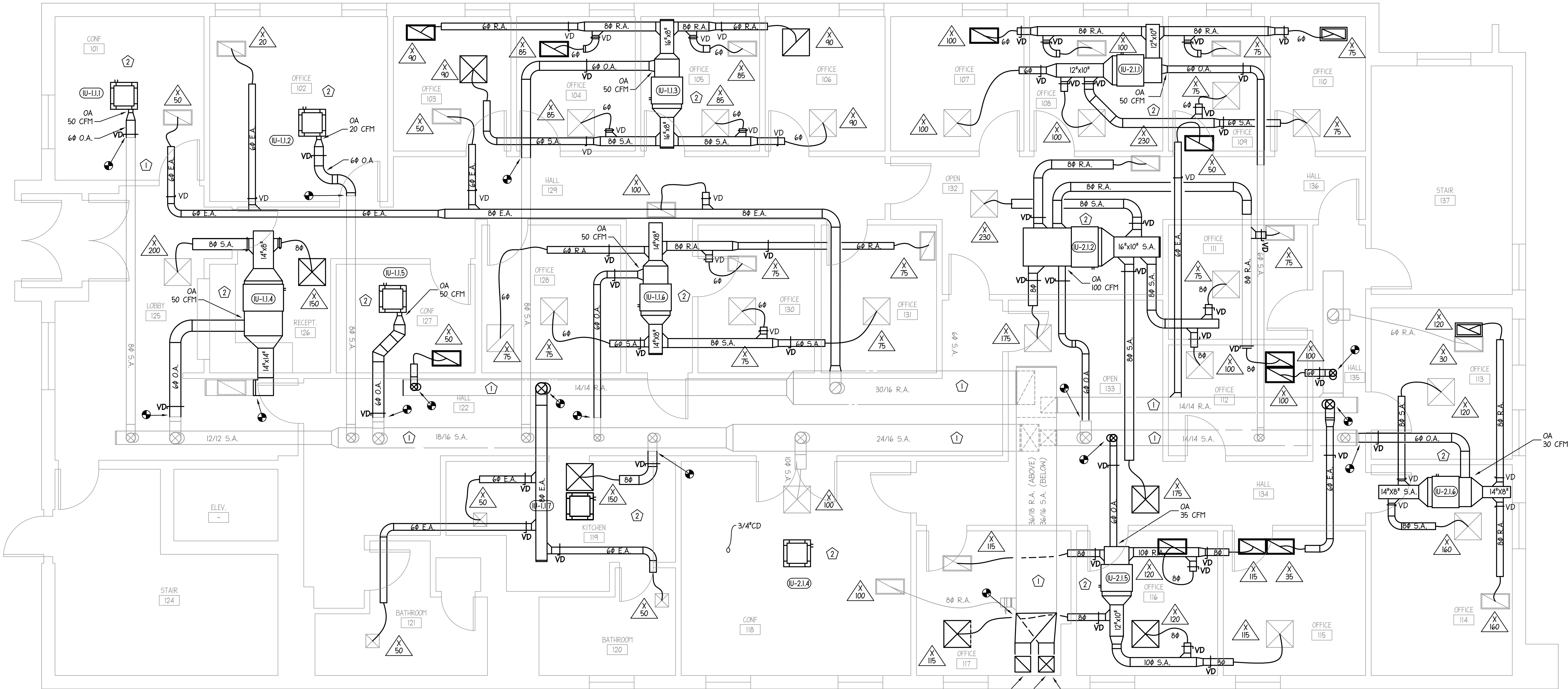


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BASEMENT
MECHANICAL
NEW WORK PLAN

M1.01



MECHANICAL NEW WORK LEGEND	
	NEW MECHANICAL TO BE FURNISHED AND INSTALLED
	EXISTING MECHANICAL TO REMAIN

MECHANICAL SPECIFIC NEW WORK NOTES:

- IN GENERAL, EXISTING SUPPLY AIR DUCTWORK SHALL BE REPURPOSED AS OUTDOOR VENTILATION AIR. EXISTING RETURN AIR DUCTWORK SHALL BE REPURPOSED VENTILATION EXHAUST AIR. UTILIZE EXISTING BRANCH TAKE-OFFS WHERE INDICATED AND CAP ALL UNUSED BRANCH TAKE-OFFS RESULTING FROM DEMOLITION SCOPE OF WORK.
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14X14 EA UP
14X14 OA UP
(INSTALL FIRE DAMPERS AT
NEW FLOOR PENETRATIONS)

INFILL FLOOR OPENING
TO LEVEL BELOW
SEE GENERAL TRADES DRAWINGS

GENERAL MECHANICAL NOTES:

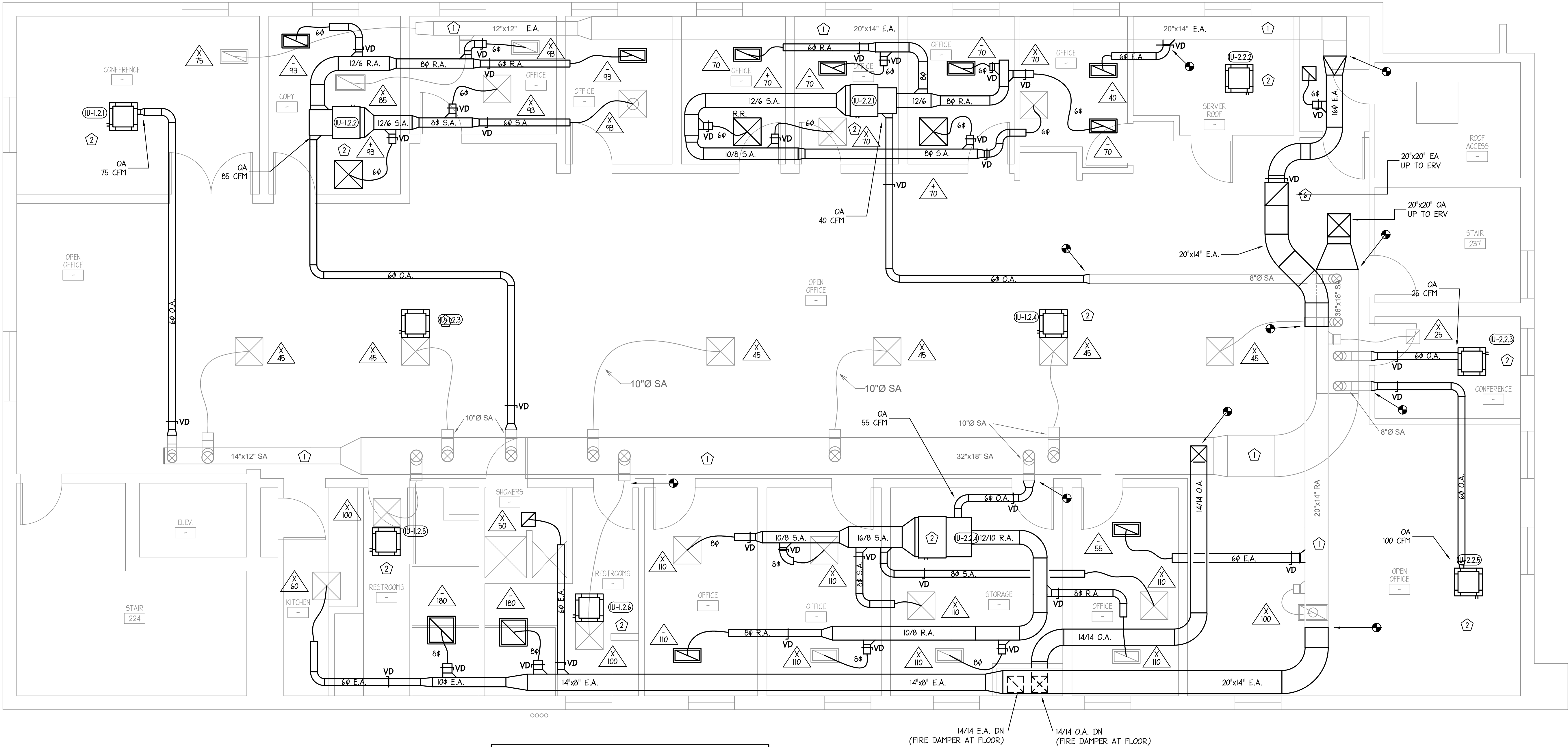
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NO.	DATE	REVISION

PROJECT #:	21201
DRAWN:	ARW
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SCALE:	1/4" = 1'-0"

FIRST FLOOR
MECHANICAL
NEW WORK PLAN

M1.11



MECHANICAL NEW WORK LEGEND	
	NEW MECHANICAL TO BE FURNISHED AND INSTALLED
	EXISTING MECHANICAL TO REMAIN

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SECOND FLOOR
MECHANICAL
NEW WORK PLAN

M1.21

ISSUED FOR
BID
NOT FOR
CONSTRUCTION



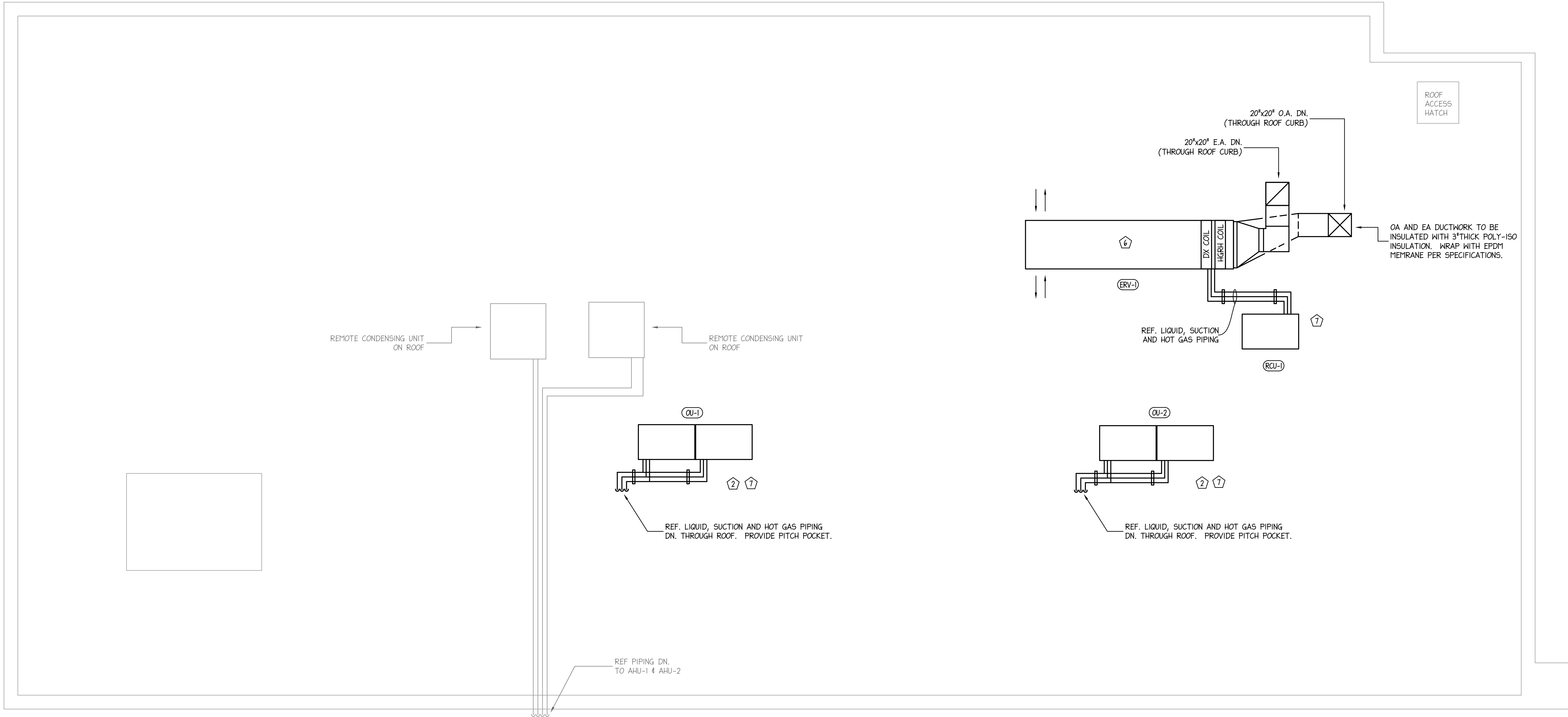
200 CHURCH STREET
BURLINGTON, VERMONT

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ROOF LEVEL
MECHANICAL
NEW WORK PLAN

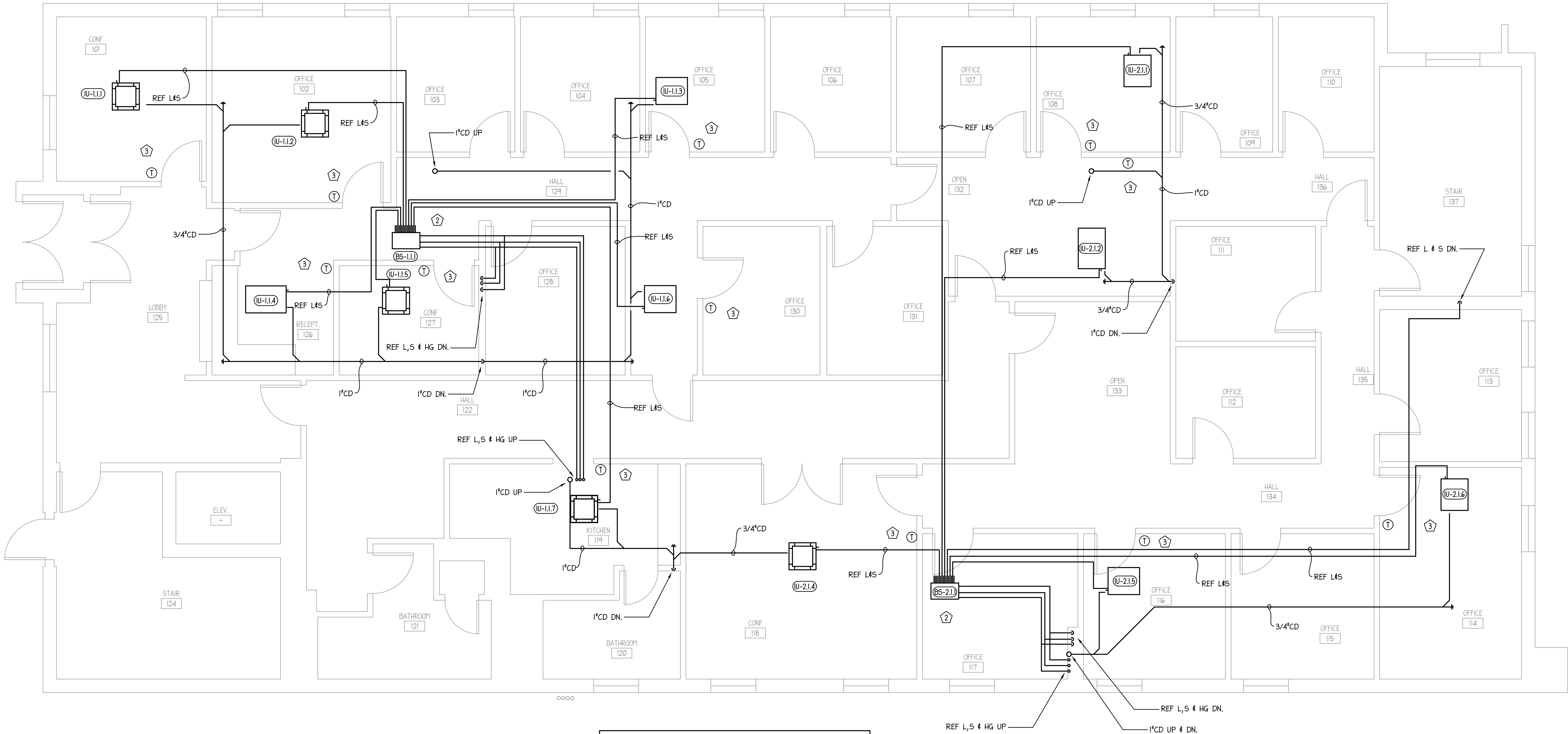
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MECHANICAL NEW WORK LEGEND	
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FIRST FLOOR
HVAC PIPING
NEW WORK PLAN

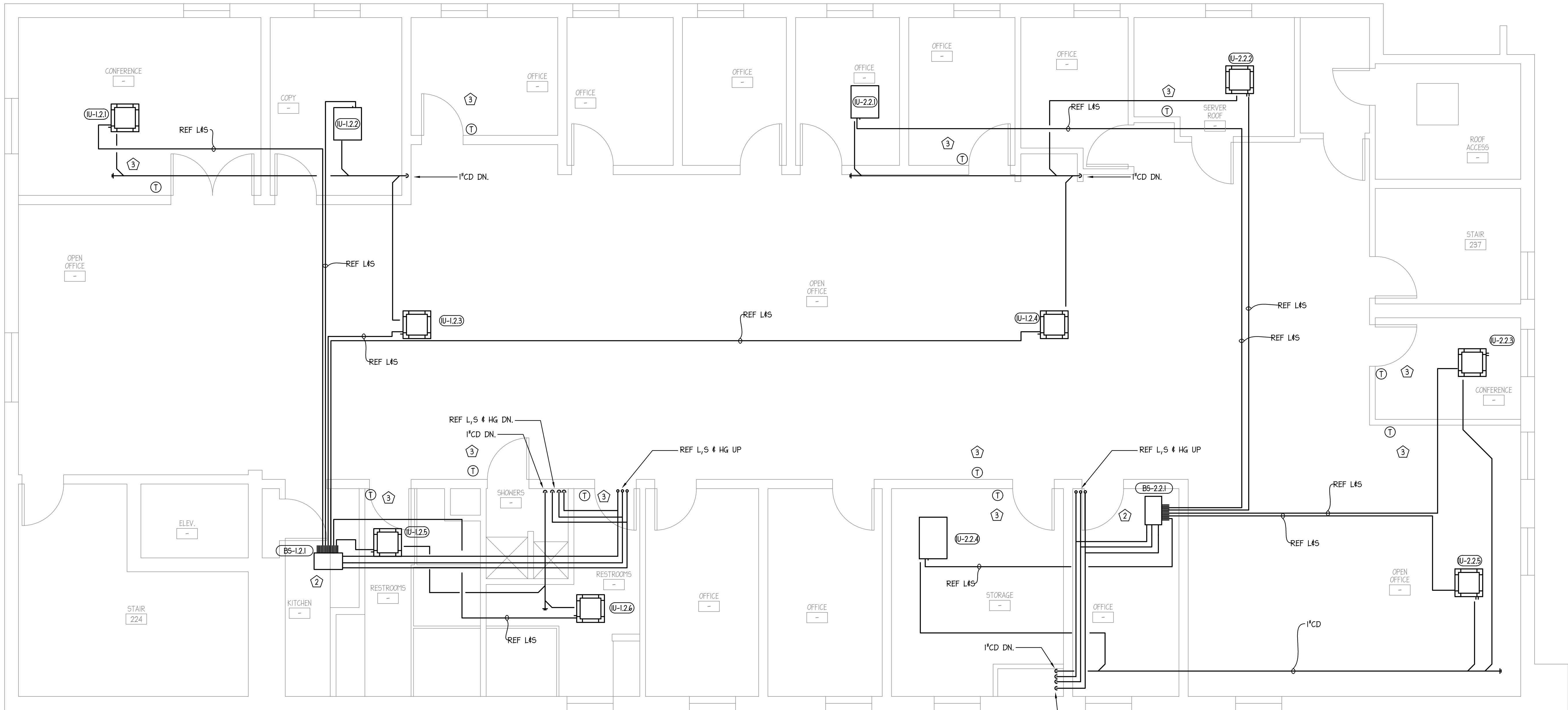
M2.11

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SECOND FLOOR
HVAC PIPING
NEW WORK PLAN

M2.21



LN
CONSULTING

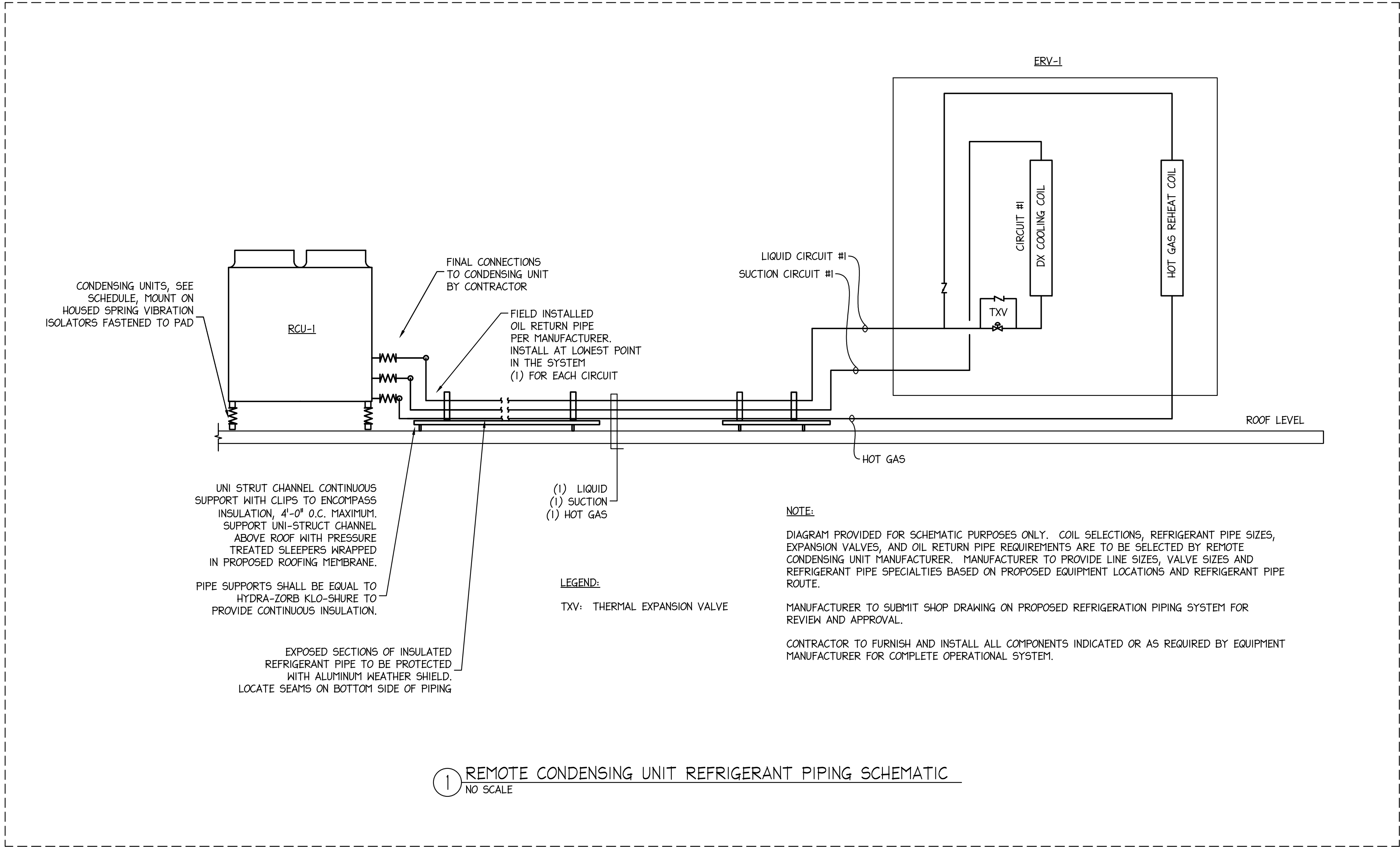
200 CHURCH STREET
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MECHANICAL ONE-LINE DIAGRAMS

M3.01





NOTE: REMOTE CONDENSING UNIT EQUIPMENT AND ASSOCIATED PIPING, CONTROLS, ROOF WORK, ELECTRICAL, ETC. SHALL BE CARRIED AS AN ADD ALTERNATE SCOPE OF WORK.

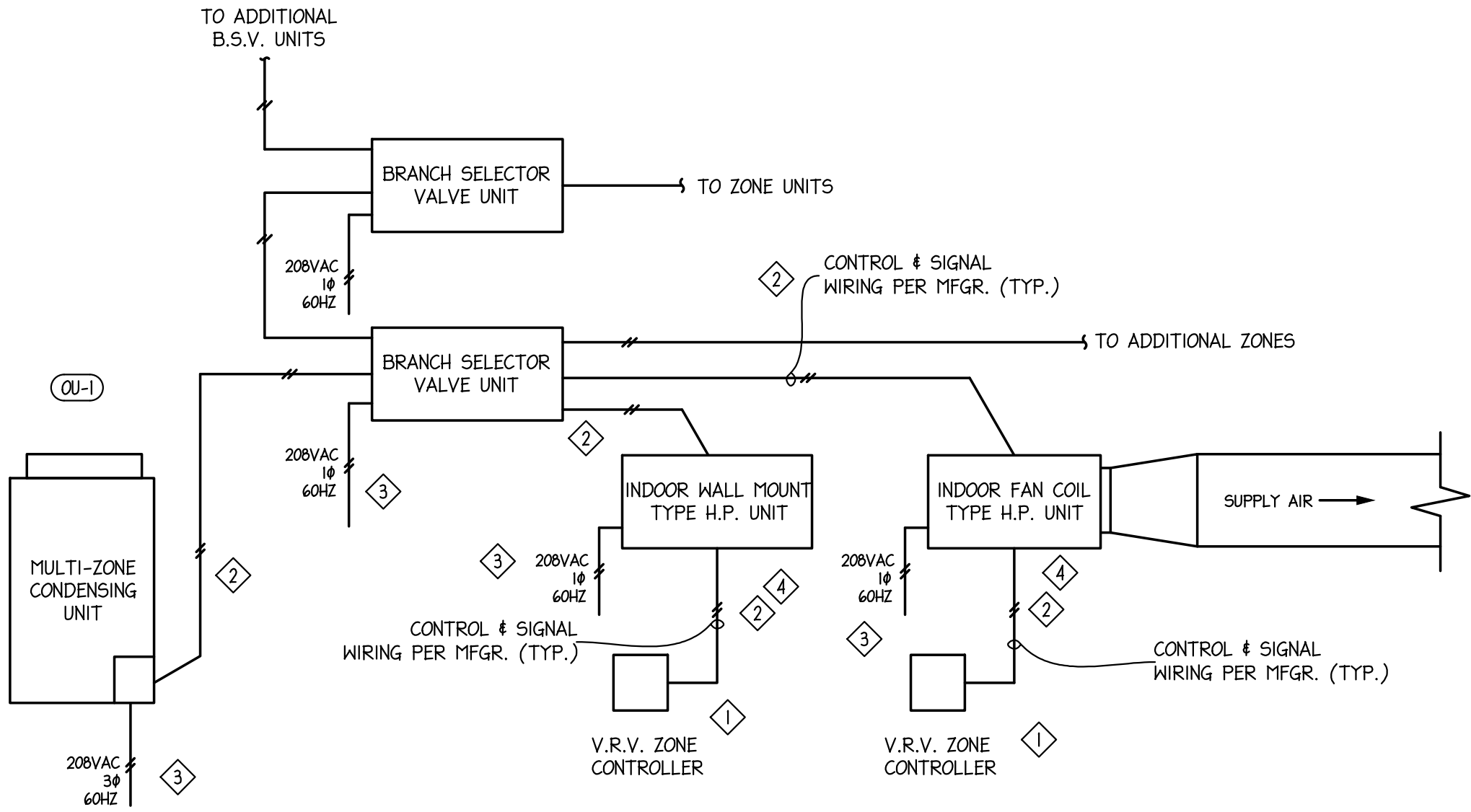
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MECHANICAL
ONE-LINE
DIAGRAMS

LEGEND	
SYMBOL	DESCRIPTION
AFS	AIR FLOW STATION
CS	CURRENT SENSOR
DM	DAMPER MOTOR ACTUATOR
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
DD	DUCT SMOKE DETECTOR (FURNISHED BY OTHERS)
DP	DIFFERENTIAL PRESSURE TRANSMITTER
F	INSTANTANEOUS FLOW
FC	FLOAT CONTROLLER
FM	FLOW METER
FS	FREEZE STAT
FT	TOTAL FLOW
HL	HUMIDITY HIGH LIMIT SWITCH
HHL	BOILER HIGH LIMIT SWITCH
LW	BOILER LOW WATER CUTOFF
PH	PHOTO-HELIC
PT	PRESSURE TRANSMITTER
RLD	REFRIGERANT ALARM SENSOR
RH	RELATIVE HUMIDITY SENSOR
T	TEMPERATURE SENSOR
SP	STATIC PRESSURE
V	VALVE ACTUATOR
VPT	VELOCITY PRESSURE TRANSMITTER
◆	SPECIFIC NOTE
⎓	THERMOMETER WELL
≡	MOTORIZED BUTTERFLY VALVE
ATC	AUTOMATIC TEMPERATURE CONTROLS
CAV	CONSTANT AIR VOLUME
CC	COOLING COIL
CF	CARBON FILTER
CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
CWR	CONDENSER WATER RETURN
CWS	CONDENSER WATER SUPPLY
EA	EXHAUST AIR
EAD	EXHAUST AIR DAMPER
ECM	ELECTRONICALLY COMMUTATED MOTOR
FF	FINAL FILTER
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
NGR	NON-SPRING RETURN
OA	OUTDOOR AIR
OAD	OUTDOOR AIR DAMPER
PF	PRE-FILTER
PHC	PRE-HEAT COIL
RA	RETURN AIR
RAF	RETURN AIR FAN
RHC	RE-HEAT COIL
SA	SUPPLY AIR
SAF	SUPPLY AIR FAN
SR	SPRING RETURN
V.A.V.	VARIABLE AIR VOLUME

DIRECT DIGITAL CONTROLS GENERAL NOTES

- THE PROPOSED CONTROLS SYSTEM SHALL UTILIZE THE BACNET COMMUNICATIONS PROTOCOL. SEE CONTROL SPECIFICATIONS FOR FURTHER INFORMATION. SYSTEM SHALL TIE INTO EXISTING AUTOMATED LOGIC CONTROLS SYSTEM.
- ALL NEW CONTROLS WORK SHALL UTILIZE A COMPLETE DIRECT DIGITAL CONTROLS SYSTEM.
- THE CONTROLS CONTRACTOR SHALL PROVIDE ALL THE NECESSARY MATERIALS, LABOR AND ACCESSORIES IN ORDER TO PROVIDE A COMPLETE WORKING DIRECT DIGITAL CONTROLS SYSTEM.
- PROVIDE A COMPLETE AND OPERATIONAL DIRECT DIGITAL CONTROLS SYSTEM INCLUDING ALL REQUIRED WIRING, PROGRAMMING, DEVICES, AND OPERATIONS MANUALS. THE CONTROLS CONTRACTOR'S WORK SHALL INCLUDE BUT NOT BE LIMITED TO: PROVIDING SENSORS FOR THE CONTROLS SYSTEM, AUTOMATIC CONTROL VALVES AND ACTUATORS, CONTROL MODULE(S), CONDUCTORS, CONDUIT, "FRONT END" GRAPHICS, PROGRAMMING, AND CONNECTION TO THE COMMUNICATIONS BUS.
- THE CONTROLS CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CONTROLS CONDUIT. ALL CONTROLS CONDUCTORS SHALL BE INSTALLED WITHIN E.M.T. OR FLEXIBLE METAL CONDUIT. THE CONTROLS CONDUIT SHALL BE A MINIMUM OF 3/4" EMT. FINAL DROPS TO TEMPERATURE SENSORS MAY BE IN 1/2" EMT. ALL CONTROL WIRING SHALL BE IN CONDUIT.
- EXTEND TEMPERATURE CONTROLS COMMUNICATION BUS TO CONTROL MODULE LOCATIONS IN E.M.T.
- A MAXIMUM DISTANCE OF 6'-0" SHALL BE PERMITTED FOR UTILIZING FLEXIBLE METAL CONDUIT OR SEAL TIGHT CONDUIT.
- THE CONTROLS SYSTEM SHALL INCLUDE A WEB ACCESS SYSTEM INCLUDING ALL REQUIRED EQUIPMENT AND PROGRAMMING TO ALLOW ALL SYSTEMS TO BE ACCESSED AND MODIFIED THROUGH THE WEB. THE CONTROLS CONTRACTOR SHALL NOT BE RESPONSIBLE FOR THE COMMUNICATIONS CONDUCTOR FROM THE IT SYSTEM.
- PROVIDE CONTROLS TO ACCOMMODATE CONTROLS POINTS LIST, CONTROL DIAGRAMS, AND SEQUENCE OF OPERATIONS.
- ALL CONTROLS CONDUCTORS SHALL BE EXTENDED TO THE TEMPERATURE CONTROLS PANELS.
- ALL CONTROLS MODULES SHALL BE MOUNTED IN A PROTECTIVE ENCLOSURE.
- PROVIDE TIME CLOCK PROGRAM FOR THE CONTROL SYSTEM.
- THE CONTROLS CONTRACTOR SHALL BE PRESENT AND PROVIDE ASSISTANCE DURING THE FINAL BALANCE OF THE NEW AIR HANDLING SYSTEMS.
- COORDINATE LOCATION OF ALL THERMOSTATS, TEMPERATURE SENSORS, CO2 SENSORS, AND CONTROL VALVES IN FIELD. VERIFY LOCATIONS WITH ENGINEER PRIOR TO INSTALLATION.
- THE TEMPERATURE CONTROLS CONTRACTOR IS RESPONSIBLE FOR ASSISTING THE COMMISSIONING AGENT DURING THE COMMISSIONING PROCESS. THE TEMPERATURE CONTROLS CONTRACTOR SHALL WORK IN CONJUNCTION WITH THE COMMISSIONING AGENT TO COMPLETE THE PRE-FUNCTIONAL TEST SHEETS FOR ALL EQUIPMENT AND SYSTEMS TO BE COMMISSIONED. THE TEMPERATURE CONTROLS CONTRACTOR SHALL BE PRESENT TO ASSIST THE COMMISSIONING AGENT DURING THE SYSTEM AND EQUIPMENT FUNCTIONAL TESTING PERIOD.
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- ALL DEVICES INDICATED ON THE CONTROL SCHEMATICS ARE INTENDED TO BE FURNISHED AND INSTALLED BY THE CONTROLS CONTRACTOR. THE TEMPERATURE CONTROLS CONTRACTOR SHALL COORDINATE DIRECTLY WITH THE DIFFERENT MECHANICAL EQUIPMENT VENDORS TO DETERMINE WHAT FACTORY SUPPLIED SENSORS, WIRING, ETC. ARE TO BE FIELD INSTALLED BY THE CONTRACTOR. ANY FACTORY SUPPLIED CONTROLS COMPONENTS THAT ARE SHIPPED LOOSE FOR FIELD INSTALLATION SHALL BE THE RESPONSIBILITY OF THE CONTROLS CONTRACTOR.
- CONTROLS CONTRACTOR TO REVIEW ARCHITECTURAL FLOOR PLANS FOR WALL AND CEILING CONSTRUCTION TYPE THROUGHOUT THE FACILITY. CONTROLS DEVICE ROUGH IN TO BE CONCEALED WITHIN WALLS AND ABOVE CEILINGS. FOR CONCRETE BLOCK WALLS, CONTROLS CONTRACTOR TO COORDINATE ROUTING AND INSTALLATION WITH MASON TO KEEP UTILITIES CONCEALED IN THE BLOCK. FOR AREAS WITH HARD CEILINGS AND WHERE CONTROLS EQUIPMENT, DAMPER, ETC. IS REQUIRED TO BE INSTALLED ABOVE A HARD CEILING, PROVIDE 24"x24" HINGED ACCESS DOOR.
- ALL 24 VOLT ELECTRICAL POWER CIRCUITS, INCLUDING TRANSFORMERS AND 120 VOLT CIRCUITS REQUIRED TO SUPPORT TRANSFORMERS SHALL BE THE RESPONSIBILITY OF THE CONTROLS CONTRACTOR. FEED ELECTRICAL CIRCUITS FROM LOCAL RECEPTACLE PANELS. COORDINATE WITH ELECTRICAL CONTRACTOR.



1 MULTI-ZONE HEAT PUMP SYSTEM SCHEMATIC DIAGRAM
N.T.S.

ALARM POINTS

HIGH DRAIN PAN LEVEL

SEQUENCE OF OPERATIONS

UNIT OPERATION
THE V.R.F. SYSTEM SHALL OPERATE TO PROVIDE SIMULTANEOUS HEATING AND COOLING UTILIZING FACTORY CONTROLS INCLUDING FACTORY 7-DAY PROGRAMMABLE THERMOSTATS (ROOM CONTROLLERS WITH INTEGRAL TEMPERATURE SENSORS).

INDOOR UNIT OPERATION
THE V.R.F. UNIT BLOWERS SHALL OPERATE BASED ON THE FACTORY THERMOSTAT CONTROLLERS. THERMOSTATS ARE TO BE SET FOR AUTO HEATING/COOLING CHANGEOVER, AUTOMATIC FAN OPERATION MODE, AND AUTOMATIC LOUVER POSITION MODE (FOR WALL MOUNTED UNITS). PROVIDE AN ADJUSTABLE OCCUPIED/UNOCCUPIED SCHEDULE.

COOLING MODE (TYPICAL FOR EACH ZONE)
UPON AN INCREASE IN SPACE TEMPERATURE ABOVE SET POINT, THE INDIVIDUAL V.R.F. INDOOR UNITS SHALL BE COMMANDED INTO COOLING MODE. THE FACTORY CONTROL SYSTEM SHALL MODULATE INDOOR AND OUTDOOR UNITS AS REQUIRED TO MAINTAIN SPACE TEMPERATURE SET POINT. THE OUTDOOR UNIT SHALL OPERATE WITH LOAD MODULATION AS REQUIRED TO MEET THE ZONE LOADS. SET UP THERMOSTATS WITH PROGRAMMED OCCUPIED COOLING SET POINT AND UNOCCUPIED SET POINTS. PROVIDE AN ADJUSTABLE DEAD BAND TO MINIMIZE CYCLING.

HEATING MODE (TYPICAL FOR EACH ZONE)
WHEN THERE IS A DECREASE IN SPACE TEMPERATURE BELOW SET POINT, THE INDIVIDUAL V.R.F. INDOOR UNITS SHALL BE COMMANDED INTO HEATING MODE. THE FACTORY CONTROL SYSTEM SHALL MODULATE INDOOR AND OUTDOOR UNITS AS REQUIRED TO MAINTAIN SPACE TEMPERATURE SET POINT. THE OUTDOOR UNIT SHALL OPERATE WITH LOAD MODULATION AS REQUIRED TO MEET THE ZONE LOADS. SET UP THERMOSTATS WITH PROGRAMMED OCCUPIED HEATING SET POINT AND UNOCCUPIED SET POINTS. PROVIDE AN ADJUSTABLE DEAD BAND TO MINIMIZE CYCLING.

◆ NOTES:

- THE CONTROLS CONTRACTOR SHALL INSTALL THE FACTORY THERMOSTATS. THE CONTROLLERS SHALL BE PROVIDED AND SET UP WITH LOCAL LOCK-OUT PROGRAMMING (PASSCODE PROTECTED).
- PROVIDE ALL COMMUNICATION AND LOW VOLTAGE WIRING REQUIRED BETWEEN SYSTEM COMPONENTS. SEE SYSTEM DIAGRAM AND MANUFACTURERS APPROVED SUBMITTALS. COMPLY WITH THE MANUFACTURERS REQUIREMENTS FOR CABLE SIZING AND CONDUCTORS. RUN ALL WIRING CONCEALED ABOVE CEILINGS AND IN WALLS.
- COORDINATE WITH THE ELECTRICAL CONTRACTOR FOR POWER WIRING TO ALL EQUIPMENT, INCLUDING LINE VOLTAGE POWER.
- INDOOR UNITS SHALL HAVE DRAIN PAN LEVEL SENSOR. SENSOR TO SHUT DOWN INDOOR UNIT ON HIGH DRAIN PAN LEVEL. PROVIDE ALARM TO SYSTEM ON A HIGH DRAIN PAN LEVEL.

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200 CHURCH STREET
BURLINGTON, VERMONT

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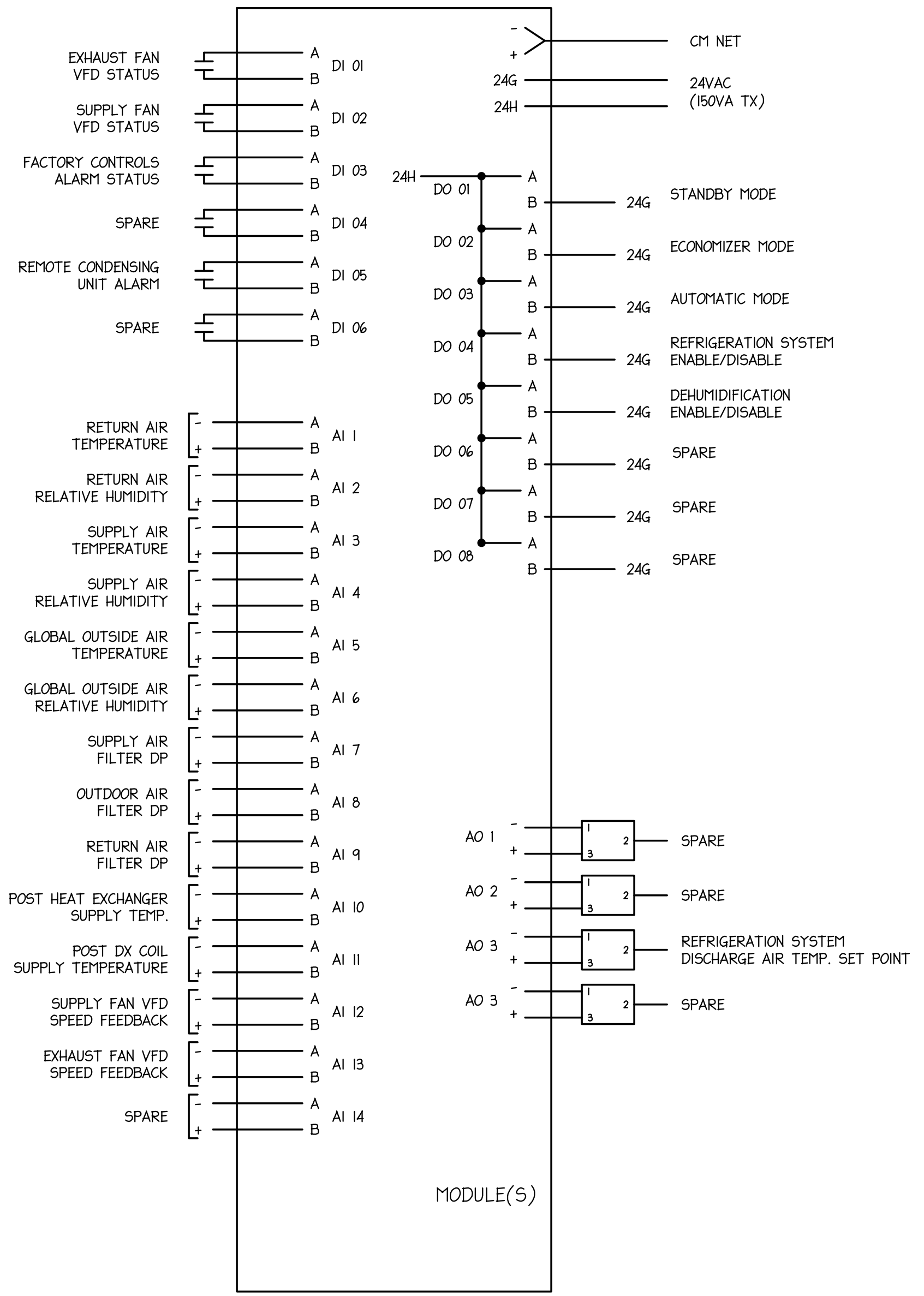
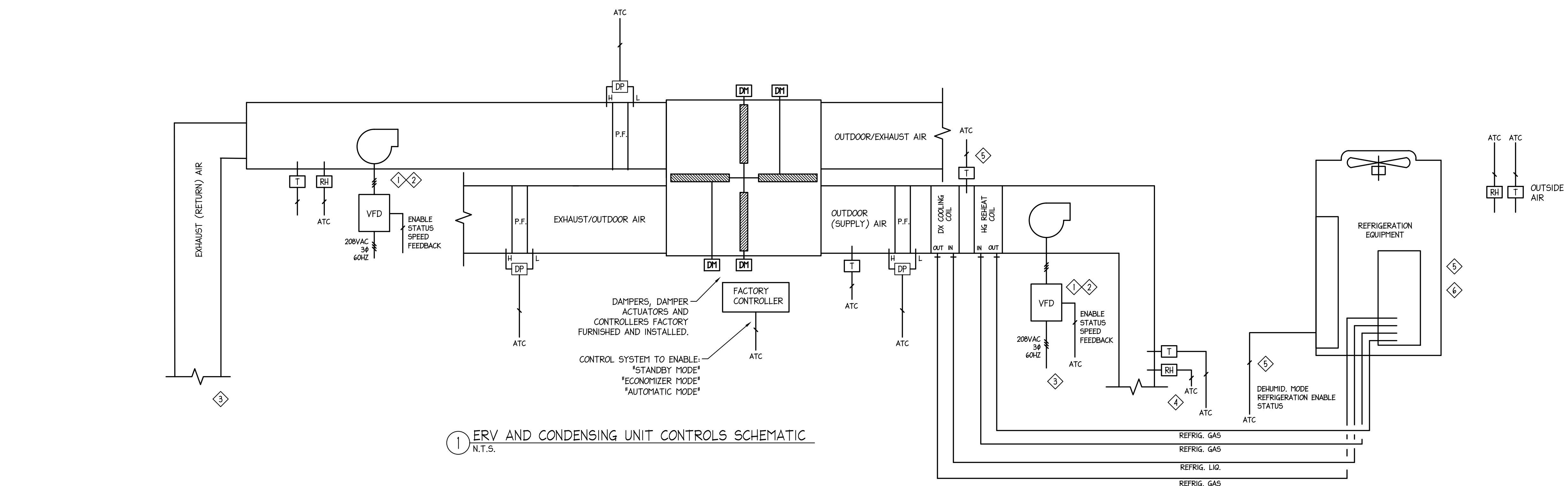
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SCALE:	AS NOTED

MECHANICAL
CONTROLS

M4.01



200 CHURCH STREET
BURLINGTON, VERMONT



SEQUENCE OF OPERATIONS

SYSTEM OPERATION:
PROVIDE A NORMALLY OCCUPIED/UNOCCUPIED SCHEDULE TO START AND STOP THE ERV UNIT. INCLUDE WEEKENDS, HOLIDAYS, ETC. WORK WITH OWNER TO ESTABLISH NORMAL OCCUPIED HOURS.

STARTUP:
DURING OCCUPIED HOURS, THE UNIT SHALL BE ENABLED IN EITHER "AUTOMATIC" ENERGY RECOVERY MODE, OR "ECONOMIZER" MODE. DURING UNOCCUPIED HOURS, THE UNIT SHALL BE IN "STAND BY" MODE WITH THE OUTSIDE AIR AND EXHAUST AIR DAMPERS CLOSED. DURING UNIT STARTUP, UNIT OUTDOOR AIR AND EXHAUST AIR DAMPERS SHALL BE OPENED. ONCE DAMPERS ARE PROVEN OPEN, THE SUPPLY AND EXHAUST FANS SHALL BE ENABLED AND RAMPED UP TO MINIMUM SPEED, AND THEN SHALL MODULATE AS NECESSARY TO MAINTAIN DUCT STATIC PRESSURE SET POINT (SET DURING BALANCING). ONCE THE FANS HAVE BEEN ENABLED, THE REMOTE REFRIGERATION COMPRESSOR(S) SHALL BE ENABLED AS NECESSARY TO MAINTAIN DISCHARGE AIR TEMPERATURE SET POINT (SEE SEQUENCE BELOW). DURING UNIT SHUTDOWN, THE REMOTE REFRIGERATION SYSTEM SHALL BE DISABLED, AFTER A PROGRAMMED TIME-DELAY (COORDINATE WITH MANUFACTURER) THE SUPPLY AND EXHAUST FANS SHALL BE DISABLED. ONCE FANS HAVE BEEN DISABLED, ALL DAMPERS ARE TO CLOSE.

FAN CONTROL:
ENERGY RECOVERY VENTILATOR SHALL BE OPERATED AT CONSTANT VOLUME CONTROL BASED UPON SUPPLY AIR DUCT AND EXHAUST AIR DUCT STATIC PRESSURE SET POINTS. THE SUPPLY AND EXHAUST FAN VFDS SHALL BE UTILIZED FOR SYSTEM BALANCING. RAMP UP SUPPLY FAN MOTOR TO MAINTAIN DESIGN CFM. RAMP UP EXHAUST FAN MOTOR TO MAINTAIN DESIGN CFM.

THE UNIT SHALL BE DISABLED DURING UNOCCUPIED PERIODS WITH TEMPORARY OVERRIDE OPERATION. PROVIDE A BUTTON ON EACH FLOOR LEVEL IN OWNER APPROVED LOCATION FOR MANUAL OVERRIDE OPERATION. VENTILATION SYSTEM SHALL OPERATION FOR 60 MINUTES (ADJ.) AFTER ACTIVATION OF OVERRIDE BUTTON.

ECONOMIZER:
ECONOMIZER MODE SHALL BE ACCOMPLISHED UTILIZING COMPARATIVE ENTHALPY. WHEN COOLING (OR HEATING) IS REQUIRED AND THE OUTDOOR AIR ENTHALPY IS BELOW (OR ABOVE) THE DISCHARGE ENTHALPY, THE UNIT SHALL OPERATE IN ECONOMIZER MODE. COOLING SHALL BE AVAILABLE DURING ECONOMIZER MODE.

PROVIDE USER PROGRAMMABLE SET POINTS FOR RELATIVE HUMIDITY/DEHUMIDIFICATION MODE SET POINT, SUPPLY AIR TEMPERATURE SET POINT.

DEHUMIDIFICATION (ADD ALTERNATE SCOPE):
BMS TO MONITOR RETURN RELATIVE HUMIDITY. WHEN RETURN R.H. IS ABOVE 50% (ADJ.), BMS TO ENABLE THE REFRIGERATION UNIT INTO DEHUMIDIFICATION MODE. PROVIDE DEADBAND TO LIMIT CYCLING. BMS SHALL PROVIDE FACTORY CONTROLLER WITH DIGITAL OUTPUT TO ENABLE DEHUMIDIFICATION MODE. FACTORY CONTROLLER SHALL MODULATE THE COOLING SYSTEM THE MODULATING HOT GAS REHEAT SYSTEM TO COOL AND DEHUMIDIFY THE AIR SO THAT THE SUPPLY AIR DISCHARGE IS 70°F (ADJ.) AND 45% (ADJ.) RH.

NOTES

1. GENERALLY ALL VFD'S ARE FACTORY INSTALLED ON THE UNIT. COORDINATE ALL CONTROL WIRING CONNECTIONS WITH THE MANUFACTURER'S DIAGRAMS.
2. WORK WITH THE AIR BALANCE CONTRACTOR TO SET UNIT MINIMUM AND MAXIMUM FAN SPEEDS.
3. WORK WITH AIR BALANCE CONTRACTOR TO DETERMINE LOWEST SUPPLY AND EXHAUST STATIC PRESSURE SET POINTS THAT WILL SATISFY AIRFLOW DEMANDS.
4. MOUNT THE TEMPERATURE AND HUMIDITY SENSORS IN THE BRANCH DUCT, IN THE CEILING SPACE, BELOW THE ROOF DECK. TEMPERATURE AND HUMIDITY SENSORS TO BE LOCATED NEAR THE DROP THROUGH THE ROOF; STATIC PRESSURE SENSOR TO BE LOCATED NEAR THE END OF THE LONGEST BRANCH.
5. REMOTE CONDENSING UNIT AND ASSOCIATED DEHUMIDIFICATION CONTROLS SHALL BE ADD ALTERNATE SCOPE OF WORK. BASE BID PRICING SHALL INCLUDE ONLY ERV START/STOP AND MONITORING FUNCTIONS.
6. REMOTE CONDENSING UNIT TO BE LOCATED (REMOTE) AND SEPARATED FROM THE ERV.

ALARM POINTS

- OUTDOOR AIR DAMPER FAIL
- EXHAUST AIR DAMPER FAIL
- SUPPLY FAN FAIL
- EXHAUST FAN FAIL
- SUPPLY AIR FILTER D.P. HIGH
- REFRIGERATION GEN. ALARM
- DISCHARGE AIR PRESSURE LOW/HIGH
- RETURN AIR HUMIDITY HIGH
- SUPPLY AIR TEMPERATURE HIGH
- SUPPLY AIR TEMPERATURE LOW
- ERV FACTORY CONTROLLER ALARM

2 ERV AND CONDENSING UNIT CONTROLS POINTS SCHEMATIC
N.T.S.

MECHANICAL
CONTROLS

M4.02

HVAC LEGEND			
HVAC PIPING ABBREVIATIONS		HVAC SYMBOLS	
— CA —	COMPRESSED AIR		AIR VENT
— CD —	CONDENSATE DRAIN		BALL VALVE
— CHS —	CHILLED WATER SUPPLY		BALANCE VALVE
— CHR —	CHILLED WATER RETURN		BUTTERFLY VALVE
— CWS —	CONDENSER WATER SUPPLY		CHECK VALVE
— CWR —	CONDENSER WATER RETURN		AUTOMATIC CONTROL VALVE (TWO-WAY)
— DCW —	DOMESTIC COLD WATER		AUTOMATIC CONTROL VALVE (THREE WAY)
— DHW —	DOMESTIC HOT WATER		FLANGED CONNECTION
— DHWR —	DOMESTIC HOT WATER RETURN		FLEXIBLE CONNECTOR
— DI —	DEIONIZED WATER		GATE VALVE
— FO —	FUEL-OIL		NEEDLE VALVE
— FW —	FILTERED WATER		PIPE CAP
— GAS —	GAS PIPING		PRESSURE GAUGE
— HPS —	HIGH PRESSURE STEAM		THERMOMETER
— HPR —	HIGH PRESSURE CONDENSATE RETURN		HOSEBIB
— HPLS —	HEAT PUMP LOOP SUPPLY		PUMP
— HPLR —	HEAT PUMP LOOP RETURN		PIPE TURNED DOWN
— HWR —	HOT WATER HEATING RETURN		PIPE TURNED UP
— HWS —	HOT WATER HEATING SUPPLY		PIPE OUTLET
— LPS —	LOW PRESSURE STEAM		PIPE PITCH
— LPR —	LOW PRESSURE CONDENSATE RETURN		PIPE REDUCER
— NPW —	NON-POTABLE COLD WATER		PIPE STRAINER
— MPR —	MEDIUM PRESSURE CONDENSATE RETURN		PIPE TEE DOWN
— PC —	PUMPED CONDENSATE		PIPE TEE FLANGE
— RL —	RAIN LEADER		PIPE UNION
— REF L —	REFRIGERANT LIQUID PIPING		PIPE WELL
— REF S —	REFRIGERANT SUCTION PIPING		PUMP SUCTION DIFFUSER
— REF H —	REFRIGERANT HOT GAS PIPING		RELIEF VALVE
— AW —	SANITARY ACID WASTE		TRIPLE DUTY VALVE
— W —	SANITARY WASTE		VALVE
— V —	VENT		VOLUME DAMPER
— V —	SANITARY VENT		BLAST GATE
			MOTORIZED VALVE ACTUATOR
			CHAIN WHEEL - SEE SPECIFICATIONS
			DUCT MOUNTED ACCESS PANEL
			DUCT CLEAN OUT
			THERMOSTAT/CO2 COMBINATION SENSOR IN NON-VRF LOCATIONS. VRF SYSTEMS SHALL UTILIZE FACTORY THERMOSTATS
HVAC DUCTWORK ABBREVIATIONS			
EA	GENERAL/TOILET EXHAUST AIR		
OA	OUTDOOR AIR		
RA	RETURN AIR		
SA	SUPPLY AIR		
HA	HOT DECK SUPPLY AIR		
CA	COLD DECK SUPPLY AIR		
HVAC ABBREVIATIONS			
RHC	REHEAT COIL		
A.F.F.	ABOVE FINISHED FLOOR		
DN	DOWN		
AHU	AIR HANDLING UNIT		
ERV	ENERGY RECOVERY VENTILATOR		
U.V.	UNIT VENTILATOR		
E.F.	EXHAUST FAN		
U.H.	UNIT HEATER		
F.H.	LABORATORY FUME HOOD		
E.T.	THERMAL EXPANSION TANK		
RCU	REMOTE CONDENSING UNIT		
RTU	PACKAGED ROOF UNIT		

NEW EQUIPMENT DESIGNATION

AHU-1

EQUIPMENT NUMBER

EXISTING EQUIPMENT DESIGNATION

AHU-1

EQUIPMENT NUMBER

MECHANICAL GENERAL NEW WORK NOTES:

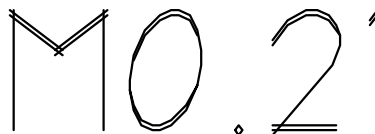

- ALL NEW AIR DUCTING SHALL BE RATED FOR AN AIR PRESSURE PER THE SPECIFICATIONS.
- ALL INSULATION SHALL BE FURNISHED AND INSTALLED AS PER THE SPECIFICATIONS.
- PROVIDE SHEET METAL GAUGE AND HANGER SPACING PER THE CURRENT EDITION OF SMACNA HVAC DUCT CONSTRUCTION STANDARDS.
- ALL 90° ELBOWS SHALL BE PROVIDED WITH TURNING VANES. PROVIDE TWO (2) TURNING VANES FOR DUCT WORK UNDER 12" WIDE, AND PROVIDE THREE (3) TURNING VANES FOR DUCTS BETWEEN 12" & 18" WIDE. PROVIDE AN ADDITIONAL TURNING VANE FOR EVERY MULTIPLE OF 3" IN DUCT WIDTH. INSTALL TURNING VANES AS PER CURRENT EDITION OF SMACNA DUCT CONSTRUCTION STANDARDS.
- ALL CAV AND VAV SYSTEMS SHALL BE COMPLETELY OPERATIONAL. THE DRAWINGS ARE SCHEMATIC IN NATURE, FIELD COORDINATION IS REQUIRED.
- PROVIDE ALL EQUIPMENT AND MATERIALS NECESSARY FOR MOUNTING ALL MECHANICAL EQUIPMENT.
- FLEXIBLE DUCTS NOT PERMITTED ON INLET OR OUTLET OF VAV BOXES.
- ALL VOLUME DAMPERS SHALL BE LOCKING QUADRANT TYPE AND CONSTRUCTED OF 18 GA. GALVANIZED STEEL.
- ALL VOLUME DAMPERS SHALL BE ULTRA LOW-LEAK AND SHALL HAVE A ROUND SHAFT WITH SHAFT SEALS AT THE PENETRATIONS IN THE DUCTWORK. VOLUME DAMPER NOT CONFORMING TO THE ULTRA-LOW LEAK STANDARD SHALL BE REMOVED AND REPLACED AT THE MECHANICAL CONTRACTORS EXPENSE.
- 5' MAXIMUM FLEXIBLE AIR DUCTS ON ALL TAKEOFFS.
- A MAXIMUM OF 90° CHANGE IN DIRECTION SHALL BE ALLOWED IN ALL FLEXIBLE DUCT TAKE-OFFS. ANY FLEXIBLE DUCT TAKE-OFFS NOT SUPPORTED OR WITH GREATER THAN 90° CHANGE IN DIRECTION SHALL BE REMOVED AND REPLACED AT THE MECHANICAL CONTRACTORS EXPENSE.
- COORDINATE THE LOCATION OF VAV BOXES WITH OTHER TRADES. ALL VAV BOXES SHALL BE INSTALLED IN AN ACCESSIBLE LOCATION APPROVED BY OWNER AND THE ENGINEER.
- ALL SUSPENDED DUCT WORK, AND PIPING SHALL BE PROVIDED WITH SEISMIC BRACING AS REQUIRED. ALL EQUIPMENT SHALL BE PROVIDED WITH SEISMIC BRACING.
- ALL DUCT WORK 144 SQ. IN. AND OVER IN CROSS SECTIONAL AREA SHALL BE FABRICATED USING DUCT-MATE FLANGES. NO SLIP AND DRIVE CONNECTIONS SHALL BE PERMITTED. TDF CONNECTIONS ARE ACCEPTABLE FOR DUCTS JOINTS OVER 30" AND 4" W.G. PRESSURE.
- COORDINATE ALL DIFFUSER INSTALLATIONS WITH CEILING GRID AND/OR ARCHITECTURAL REFLECTED CEILING PLAN.
- MECHANICAL CONTRACTOR SHALL REFERENCE CONTROLS DRAWINGS IN ADDITION TO MECHANICAL SCHEDULES FOR MOTORS REQUIRING VARIABLE FREQUENCY DRIVES. SPECIFICATIONS SHALL BE REFERENCED FOR VFD REQUIREMENTS. VFDs SHALL BE FURNISHED AND INSTALLED AS FOLLOWS:
 - WHEN VFD IS PROVIDED WITH THE MECHANICAL EQUIPMENT, SUCH AS ERV UNITS, ETC., THEY SHALL BE FURNISHED AND INSTALLED BY MANUFACTURER.
 - WHEN VFD IS REQUIRED FOR EQUIPMENT AS INDICATED IN CONTROLS DIAGRAMS AND/OR SCHEDULES, SUCH AS PUMPS, FAN, ETC., THEY SHALL BE FURNISHED AND INSTALLED BY THE ELECTRICAL CONTRACTOR.

TESTING AND BALANCING GENERAL NOTES:

- THE BALANCE CONTRACTOR SHALL SUBMIT A FORMAL BALANCE REPORT AT THE COMPLETION OF EACH PHASE OF WORK.
- THE BALANCE CONTRACTOR SHALL BE RESPONSIBLE FOR TEMPERATURE CONTROL VERIFICATION, SEQUENCE OF OPERATIONS VERIFICATION, AND SYSTEM COMMISSIONING AT THE COMPLETION OF EACH PHASE OF WORK. THE BALANCE CONTRACTOR SHALL BE PRESENT DURING THE FINAL CONTROLS SYSTEM COMMISSIONING PROCESS AND SHALL ASSIST THE COMMISSIONING AGENT, THE CONTROLS CONTRACTOR, AND THE MECHANICAL CONTRACTOR DURING THE COMMISSIONING PROCESS.
- THE TESTING AND BALANCE AGENT SHALL BE RESPONSIBLE FOR TEMPERATURE CONTROLS SEQUENCE OF OPERATIONS VERIFICATION AS OUTLINED IN THE SPECIFICATIONS. THE TESTING AND BALANCING AGENT SHALL WORK WITH THE CONTROLS CONTRACTOR TO VERIFY THE CORRECT OPERATIONS OF ALL CONTROLS SEQUENCES.
- THE TESTING AND BALANCING AGENT SHALL BE RESPONSIBLE FOR ASSISTING THE COMMISSIONING AGENT AS REQUIRED. THE TESTING AND BALANCING AGENT SHALL BE ON SITE DURING THE COMMISSIONING PROCESS, AND SHALL WORK WITH THE COMMISSIONING AGENT TO VERIFY THE CORRECT OPERATIONS OF ALL CONTROLS SEQUENCES.

GENERAL ALTERNATE EQUIPMENT NOTES:

- ALTERNATE EQUIPMENT: SUBMIT PRELIMINARY DATA TO ENGINEER FOR WRITTEN APPROVAL FOR ALTERNATE EQUIPMENT.
- GENERAL ALTERNATE NOTE: THE MECHANICAL, PLUMBING AND ELECTRICAL DESIGNS ARE BASED ON THE SCHEDULED MECHANICAL EQUIPMENT. IF APPROVED ALTERNATE MECHANICAL EQUIPMENT IS PROVIDED BUT THE POWER REQUIREMENTS DIFFER FROM THE PROPOSED EQUIPMENT, THE MECHANICAL CONTRACTOR SHALL COORDINATE ALL REQUIREMENTS WITH THE ELECTRICAL CONTRACTOR INCLUDING CIRCUIT BREAKER, CONDUCTOR, AND CONDUIT SIZES. ANY ALTERNATE EQUIPMENT FEEDS SHALL STILL COME FROM THE SAME PANEL AS CURRENTLY DESIGNED. IF THE EQUIPMENT PIPING OR DUCT CONNECTION LOCATIONS OR SIZES DIFFER FROM THE PROPOSED EQUIPMENT, THE MECHANICAL CONTRACTOR SHALL COORDINATE AND PROVIDE ALL REQUIRED MODIFICATIONS AS REQUIRED TO ACCOMMODATE ALTERNATE UNIT.
- WHERE MAKE AND MODEL INDICATED IN THE EQUIPMENT SCHEDULES. THIS SHALL BE CONSIDERED THE BASIS OF DESIGN. PROVIDE SPECIFIED EQUIPMENT OR APPROVED EQUAL.

TITLE BLOCK LEGEND		
	DRAWING TRADE	
	DRAWING TYPE	
	DRAWING NUMBER	
	BUILDING LEVEL	
<hr/>		
DRAWING TRADE		
<u>SYMBOL</u>	<u>DESCRIPTION</u>	
E	ELECTRICAL	
FP	FIRE PROTECTION	
M	MECHANICAL HVAC	
P	PLUMBING	
<hr/>		
HVAC TRADE DRAWING TYPES		
<u>SYMBOL</u>	<u>DESCRIPTION</u>	
0	DEMOLITION PLANS	
1	NEW DUCTWORK PLANS	
2	NEW PIPING PLANS	
3	ONE-LINE DIAGRAMS	
4	PIPING AND DUCTWORK SECTIONS	
5	LEGENDS, NOTES AND SCHEDULES	
6	DETAILS	

ISSUED FOR
BID
NOT FOR
CONSTRUCTION



200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION
PROJECT #:	21201	
DRAWN:		
CHECKED:		
DATE:	8/17/2022	
SCALE:	N.T.S.	

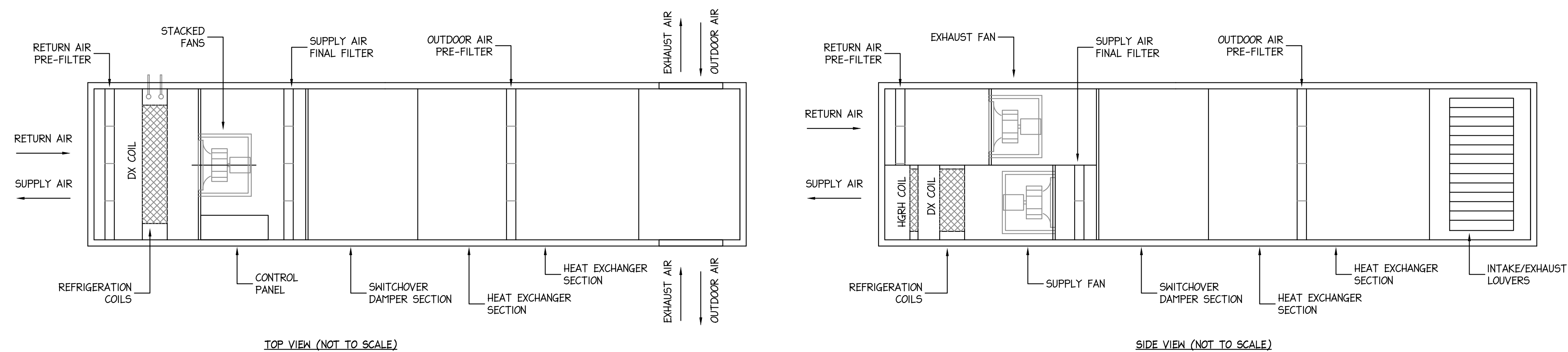
MECHANICAL
NOTES & LEGENDS

M5.01

					SUPPLY FAN								EXHAUST FAN								DAMPERS		OUTDOOR AIR PRE FILTER		RETURN AIR PRE FILTER		SUPPLY AIR FINAL FILTER	
TAG	DESCRIPTION	BASIS OF DESIGN	SUPPLY AIR	EXHAUST AIR	TYPE	MAX E.S.P.	MOTOR	RPM	VOLTS	Φ	BHP	HP	TYPE	MAX E.S.P.	MOTOR	RPM	VOLTS	Φ	BHP	HP	TYPE	TYPE	TYPE	TYPE	TYPE			
(ERV-1)	ENERGY RECOVERY VENTILATOR	TEHPFF RG-L 2000	1800 CFM	1800 CFM	DIRECT DRIVE	1.25" W.C.	ODP	182	208	3	1.39	2.0	DIRECT DRIVE	1.25" W.C.	ODP	182	208	3	1.23	1.5	FACTORY STANDARD	2" MERV 10 REPLACEABLE	2" MERV 10 REPLACEABLE	2" MERV 13 REPLACEABLE	2" MERV 13 REPLACEABLE			

1. PROVIDE UNIT CONFIGURATION INDICATED WITH OUTDOOR AIR AND EXHAUST CONNECTIONS LOCATED ON THE SAME END OF THE UNIT.
2. UNIT TO HAVE DOUBLE WALL INSULATED WALLS, ROOF AND FLOOR.
3. UNIT SHALL BE MOUNTED ON STRUCTURAL SUPPORT SYSTEM. COORDINATE WITH STRUCTURAL DRAWINGS.
4. FANS ARE TO BE HIGH EFFICIENCY DIRECT DRIVE PLENUM FANS. FANS TO BE PROVIDED WITH SPRING VIBRATION ISOLATED BASES.
5. FANS SHALL BE VARIABLE SPEED WITH FACTORY FURNISHED AND INSTALLED VARIABLE SPEED DRIVES FOR SYSTEM BALANCING. ECM FANS WITH LOCAL SPEED CONTROL WILL BE AN ACCEPTABLE ALTERNATIVE TO VFDS.
6. PROVIDE SINGLE POINT POWER CONNECTION WITH FACTORY INSTALLED NON-FUSED DISCONNECT SWITCH.
7. HEAT EXCHANGERS SHALL INCLUDE "DUAL CORE PLUS" COATING (OR EQUIVALENT) TO PROVIDE BOTH SENSIBLE AND LATENT ENERGY RECOVERY.
8. DRAIN PANS AND DRAINAGE SHALL BE PROVIDED WITH FACTORY FURNISHED AND INSTALLED STEEL CONSTRUCTION.
9. FURNISH AND INSTALL DIRECT EXPANSION REFRIGERATION COIL FOR POST CONDITIONING OF THE VENTILATION AIR. COIL CASING AND COIL DRAIN PAN SHALL BE OF STAINLESS STEEL CONSTRUCTION.
10. UNIT TO BE WEATHER PROOF CONSTRUCTION FOR INSTALLATION OUTSIDE. PROVIDE LOUVERS OR HOODS FOR INTAKE AND EXHAUST OPENINGS.
11. PROVIDE HINGED ACCESS DOORS AND LOCKING LATCHES FOR ALL SECTIONS.
12. PROVIDE FACTORY INSTALLED SWITCHOVER DAMPERS AND ACTUATORS. CONTROL DAMPERS SHALL BE CONTROLLED BY FACTORY INSTALLED CONTROL PANEL AND FACTORY STANDARD SEQUENCE OF OPERATIONS TO PROVIDE "STANDBY MODE", "AUTOMATIC MODE", AND "ECONOMIZER MODE".

SUMMER HEAT EXCHANGER DESIGN					WINTER HEAT EXCHANGER DESIGN					NO EXHAUST		NO EXHAUST	
ENTERING O.A.		LEAVING SUPPLY		ENTERING EXHAUST	A.P.D.	ENTERING O.A.		LEAVING SUPPLY		ENTERING EXHAUST	A.P.D.		
DB	86.0° F	79.2° F	75.0° F	< 0.75'		DB	-13° F	61.0° F	70.0° F	< 0.75'			
WB	69.0° F	66.1° F	62.5° F			WB	-13° F	45.1° F	52.0° F				
DIRECT EXPANSION COIL DESIGN										REFRIGERATION SIDE			
COIL SIZE		E.A.T.	L.A.T.	AIRFLOW (CFM)	CAPACITY TOTAL (TMBH)	CAPACITY SENSIBLE (TMBH)		MAX. AIR PD (IN W.G.)		TYPE	SUCTION	P.D.	
23"H X 26"W		79.2°F DB 66.1°F WB	53.2 DB 53.0 WB	1,800	70.8	50.4		0.35		R410A	45.0°F	3.05 PSIG	
HOT GAS REHEAT COIL DESIGN										REFRIGERATION SIDE			
COIL SIZE		E.A.T.	L.A.T.	AIRFLOW (CFM)	CAPACITY TOTAL (TMBH)	CAPACITY SENSIBLE (TMBH)		MAX. AIR PD (IN W.G.)		TYPE	CONDENSING	P.D.	
23"H X 26"W		54.0°F DB 54.0°F WB	70.0 DB 53.0 WB	1,800	32.7	N/A		0.11		R410A	140.0°F	0.04 PSIG	
ELECTRICAL (SINGLE POINT CONNECTION)													
208V-3Ø					12.5 FLA	20.0 MCA		20.0 AMP MOCP					

[illegible]

◆ NOTES:

1. FURNISH AND INSTALL ALL LIQUID/SUCTION PIPING BETWEEN EVAPORATOR UNITS AND CONDENSING UNIT. COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND ASHRAE REQUIREMENTS.
2. FURNISH AND INSTALL VARIABLE CAPACITY SCROLL COMPRESSOR FOR MODULATION OF CONDENSING UNIT CAPACITY. COORDINATE MECHANICAL CONTROLS REQUIREMENTS WITH MANUFACTURER.
3. PROVIDE MODULATING HOT GAS REHEAT CONTROLS.
4. FURNISH THERMAL EXPANSION VALVE, HOT GAS REHEAT CONTROL VALVE AND RECEIVER TANK FOR INSTALLATION BY MECHANICAL CONTRACTOR.
5. EQUIPMENT VENDOR TO PROVIDE REFRIGERATION PIPING DESIGN INCLUDING PIPE SIZES BASED ON EQUIPMENT LOCATIONS.
6. COOLING ONLY WITH HOT GAS REHEAT CAPABILITY. PROVIDE FACTORY REFRIGERATION CONTROLS.
7. PROVIDE SINGLE POINT POWER CONNECTION WITH FACTORY DISCONNECT SWITCH.



200 CHURCH STREET
BURLINGTON, VERMONT

[illegible]

MECHANICAL SCHEDULES

M5.02

AIR SOURCE HEAT PUMP V.R.V. OUTDOOR UNIT SCHEDULE										
TAG	DESCRIPTION	MAKE & MODEL	COOLING	HEATING	REFR.	IEER (DUCTED)	COP (DUCTED)	ELEC. DATA	MCA	NOTES:
(OU-1)	SYSTEM - 1 OUTDOOR HEAT RECOVERY UNIT	DAIKIN AURORA SERIES RELQ192TATJU	184 MBH	192 MBH	R-410A	19.00	2.2 @ 17°F	208V/60HZ/3PH	76.5 MCA + 76.5 MCA 80.0 MOP + 80.0 MOP	1 2 3 4 5
(OU-2)	SYSTEM - 2 OUTDOOR HEAT RECOVERY UNIT	DAIKIN AURORA SERIES RELQ192TATJU	184 MBH	192 MBH	R-410A	19.00	2.2 @ 17°F	208V/60HZ/3PH	76.5 MCA + 76.5 MCA 80.0 MOP + 80.0 MOP	1 2 3 4 5
◆ NOTES: 1. FURNISH AND INSTALL ALL LIQUID, SUCTION, H/L PIPING BETWEEN EVAPORATOR UNITS AND CONDENSING UNIT. COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS. 2. EQUIPMENT SELECTIONS BASED ON DAIKIN VRV AURORA SYSTEM. HEATING CAPABILITY DOWN TO -22°F. 100% CAPACITY AT 0°F, 85% AT -13°F, AND 60% AT -22°F. 3. PROVIDE TRINNING KIT FOR GAS, LIQUID, H/L PIPES AS REQUIRED TO CONNECT CONDENSING UNITS TOGETHER AS ONE. 4. PROVIDE INTELLIGENT TOUCH CONTROLLER- MODEL DCS60IC71. 5. PROVIDE BAGNET INTERFACE- MODEL DMS502B71.										

AIR SOURCE HEAT RECOVERY V.R.V. BRANCH SELECTOR UNIT SCHEDULE										
TAG	DESCRIPTION	MAKE & MODEL	REFRIGERANT	BRANCHES	CONNECTED UNITS	ELECTRICAL	M.C.A.	MAX BRK.	NOTES	
(BS-10)	SYSTEM #1 BRANCH SELECTOR BOX	DAIKIN BS094TVJ	R-410A	1	(1) INDOOR UNITS	208V/1P	0.1A	15 AMP	1 2 3 4	
(BS-11)	SYSTEM #1 BRANCH SELECTOR BOX	DAIKIN BS8054TVJ	R-410A	8	(7) INDOOR UNITS	208V/1P	0.8A	15 AMP	1 2 3 4	
(BS-12)	SYSTEM #1 BRANCH SELECTOR BOX	DAIKIN BS8054TVJ	R-410A	8	(6) INDOOR UNITS	208V/1P	0.8A	15 AMP	1 2 3 4	
(BS-20)	SYSTEM #2 BRANCH SELECTOR BOX	DAIKIN BS094TVJ	R-410A	1	(1) INDOOR UNITS	208V/1P	0.1A	15 AMP	1 2 3 4	
(BS-21)	SYSTEM #2 BRANCH SELECTOR BOX	DAIKIN BS8054TVJ	R-410A	8	(6) INDOOR UNITS	208V/1P	0.8A	15 AMP	1 2 3 4	
(BS-22)	SYSTEM #2 BRANCH SELECTOR BOX	DAIKIN BS6054TVJ	R-410A	6	(5) INDOOR UNITS	208V/1P	0.6A	15 AMP	1 2 3 4	
◆ NOTES: 1. FURNISH AND INSTALL ALL LIQUID, SUCTION, H/L PIPING BETWEEN INDOOR UNITS, BRANCH SELECTOR BOX(ES) AND OUTDOOR UNIT(S). COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS. SEE SCHEMATIC ONE-LINE PIPING DIAGRAMS FOR PRELIMINARY PIPE SIZING. 2. PROVIDE STRUCTURAL SUPPORT WITH VIBRATION ISOLATION CLAMPS FOR SUSPENDED EVAPORATOR OR BS BOX UNITS. 3. LOCATE ALL EQUIPMENT TO PROVIDE MANUFACTURER'S REQUIRED CLEARANCES. 4. PROVIDE ISOLATION VALVES FOR EACH REFRIGERATION CIRCUIT. CAP UNUSED BRANCHES FOR FUTURE CONNECTION.										

AIR SOURCE HEAT RECOVERY V.R.V. INDOOR UNIT SCHEDULE										SYSTEM - 1
TAG	MAKE & MODEL	COOLING	HEATING	AIRFLOW	BS BOX	REFR.	ELECTRICAL	M.C.A.	REMARKS	
(U-1.0)	DAIKIN FXM1Q-72-MVJU	72.0 MBH	81.0 MBH	1,764 CFM	(BS-1.0)	R410A	208/60HZ/1PH	9.5 MCA 15 MOP	1 2 3 4 5 6	
(U-1.1)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-1.1)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.12)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-1.1)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.13)	DAIKIN FXDQ-18-MVJU	18.0 MBH	20.0 MBH	350 CFM	(BS-1.1)	R410A	208/60HZ/1PH	1.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.14)	DAIKIN FXDQ-18-MVJU	18.0 MBH	20.0 MBH	350 CFM	(BS-1.1)	R410A	208/60HZ/1PH	1.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.15)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-1.1)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.16)	DAIKIN FXDQ-12-MVJU	12.0 MBH	13.5 MBH	226 CFM	(BS-1.1)	R410A	208/60HZ/1PH	0.9 MCA 15 MOP	1 2 3 4 5 6	
(U-1.17)	DAIKIN FXZQ-12-TAVJU	12.0 MBH	13.5 MBH	247 CFM	(BS-1.1)	R410A	208/60HZ/1PH	0.4 MCA 15 MOP	1 2 3 4 5 6	
(U-1.2)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-1.2)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.22)	DAIKIN FXDQ-18-TAVJU	18.0 MBH	20.0 MBH	350 CFM	(BS-1.2)	R410A	208/60HZ/1PH	1.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.23)	DAIKIN FXZQ-18-TAVJU	18.0 MBH	20.0 MBH	353 CFM	(BS-1.2)	R410A	208/60HZ/1PH	0.6 MCA 15 MOP	1 2 3 4 5 6	
(U-1.24)	DAIKIN FXDQ-18-MVJU	18.0 MBH	20.0 MBH	350 CFM	(BS-1.2)	R410A	208/60HZ/1PH	1.3 MCA 15 MOP	1 2 3 4 5 6	
(U-1.25)	DAIKIN FXZQ-12-TAVJU	12.0 MBH	13.5 MBH	247 CFM	(BS-1.2)	R410A	208/60HZ/1PH	0.4 MCA 15 MOP	1 2 3 4 5 6	
(U-1.26)	DAIKIN FXZQ-12-TAVJU	12.0 MBH	13.5 MBH	247 CFM	(BS-1.2)	R410A	208/60HZ/1PH	0.4 MCA 15 MOP	1 2 3 4 5 6	
◆ NOTES: 1. FURNISH AND INSTALL ALL LIQUID, SUCTION, AND H/L PIPING BETWEEN INDOOR UNITS, BRANCH SELECTOR BOX(ES) AND OUTDOOR UNIT(S). COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS. SEE SCHEMATIC ONE-LINE PIPING DIAGRAMS FOR PRELIMINARY PIPE SIZING. 2. PROVIDE STRUCTURAL SUPPORT WITH VIBRATION ISOLATED SUPPORTS FOR SUSPENDED EVAPORATOR OR BS BOX UNITS. 3. EACH UNIT TO BE EQUIPPED WITH INTEGRAL CONDENSATE LIFT PUMP AS NEEDED. 4. EACH UNIT TO BE INSTALLED WITH WIRED WALL MOUNTED TEMPERATURE CONTROLLER. COORDINATE ALL THERMOSTAT LOCATIONS WITH OWNER PRIOR TO INSTALLATION. 5. FAN COIL TYPE UNITS SHALL BE PROVIDED WITH DUCT MOUNTED FILTERS UPSTREAM OF RETURN INLET. FILTERS TO BE MERV 8 EFFICIENCY. SEE MANUFACTURER'S INSTALLATION INSTRUCTIONS FOR MORE INFORMATION. 6. LOCATE ALL EQUIPMENT TO PROVIDE MANUFACTURER'S REQUIRED CLEARANCES. 7. ADD ALTERNATE SCOPE OF WORK.										

AIR SOURCE HEAT RECOVERY V.R.V. INDOOR UNIT SCHEDULE										SYSTEM - 2
TAG	MAKE & MODEL	COOLING	HEATING	AIRFLOW	BS BOX	REFR.	ELECTRICAL	M.C.A.	REMARKS	
(U-2.0)	DAIKIN FXM1Q-72-MVJU	72.0 MBH	81.0 MBH	1,764 CFM	(BS-2.0)	R410A	208/60HZ/1PH	9.5 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.1)	DAIKIN FXDQ-18-MVJU	18.0 MBH	20.0 MBH	350 CFM	(BS-2.1)	R410A	208/60HZ/1PH	1.3 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.12)	DAIKIN FXDQ-24-MVJU	24.0 MBH	27.0 MBH	460 CFM	(BS-2.1)	R410A	208/60HZ/1PH	1.4 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.13)	DAIKIN FXAQ-12-PVJU	12.0 MBH	13.5 MBH	290 CFM	(BS-2.1)	R410A	208/60HZ/1PH	0.4 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.14)	DAIKIN FXZQ-15-TAVJU	15.0 MBH	17.0 MBH	282 CFM	(BS-2.1)	R410A	208/60HZ/1PH	0.4 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.15)	DAIKIN FXDQ-18-MVJU	18.0 MBH	20.0 MBH	350 CFM	(BS-2.1)	R410A	208/60HZ/1PH	1.3 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.16)	DAIKIN FXDQ-12-MVJU	12.0 MBH	13.5 MBH	280 CFM	(BS-2.1)	R410A	208/60HZ/1PH	0.9 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.2)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-2.2)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.22)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-2.2)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.23)	DAIKIN FXZQ-05-TAVJU	5.8 MBH	6.5 MBH	229 CFM	(BS-2.2)	R410A	208/60HZ/1PH	0.3 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.24)	DAIKIN FXDQ-24-MVJU	24.0 MBH	27.0 MBH	460 CFM	(BS-2.2)	R410A	208/60HZ/1PH	1.4 MCA 15 MOP	1 2 3 4 5 6 7	
(U-2.25)	DAIKIN FXZQ-18-TUVJU	18.0 MBH	20.0 MBH	353 CFM	(BS-2.2)	R410A	208/60HZ/1PH	0.6 MCA 15 MOP	1 2 3 4 5 6 7	
◆ NOTES: 1. FURNISH AND INSTALL ALL LIQUID, SUCTION, AND H/L PIPING BETWEEN INDOOR UNITS, BRANCH SELECTOR BOX(ES) AND OUTDOOR UNIT(S). COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS. SEE SCHEMATIC ONE-LINE PIPING DIAGRAMS FOR PRELIMINARY PIPE SIZING. 2. PROVIDE STRUCTURAL SUPPORT WITH VIBRATION ISOLATION CLAMPS FOR SUSPENDED EVAPORATOR OR BS BOX UNITS. 3. EACH UNIT TO BE EQUIPPED WITH INTEGRAL CONDENSATE LIFT PUMP AS NEEDED. 4. EACH UNIT TO BE INSTALLED WITH WIRED WALL MOUNTED TEMPERATURE CONTROLLER. COORDINATE ALL THERMOSTAT LOCATIONS WITH OWNER PRIOR TO INSTALLATION. 5. FAN COIL TYPE UNITS SHALL BE PROVIDED WITH DUCT MOUNTED FILTERS UPSTREAM OF RETURN INLET. FILTERS TO BE MERV 8 SEE MANUFACTURER'S INSTALLATION INSTRUCTIONS FOR MORE INFORMATION. 6. SYSTEM IS TO BE PROVIDED WITH A BAGNET INTERFACE SO THAT UNIT SET POINTS AND CONTROL CAN BE OPERATED VIA THE DDC SYSTEM. A SPACE MOUNTED TEMPERATURE SENSOR IS TO BE INSTALLED FOR EACH INDOOR UNIT WHICH THE INDOOR UNITS WILL CONTROL TO. 7. LOCATE ALL EQUIPMENT TO PROVIDE MANUFACTURER'S REQUIRED CLEARANCES.										

CONDENSATE LIFT PUMP SCHEDULE						
TAG	DESCRIPTION	MAKE & MODEL	CAPACITY	INLET	OUTLET	NOTES
(CP-1)	CONDENSATE REMOVAL PUMP	ASPEN PUMPS MINI-AQUA	1.6 GPH @ 33 FT HD.	9/16" ID	1/4" ID	1 2 3 4
(CP-2)	CONDENSATE REMOVAL PUMP	ASPEN PUMPS MINI-TANK	2.6 GPH @ 39 FT HD.	1-1/8" ID	3/8" ID	1 2 3 4
◆ NOTES: 1. PROVIDE POWER CABLE. FEED FROM EQUIPMENT POWER SUPPLY. 2. PROVIDE RESERVOIR, FILTER, FLOAT, ANTI-SIPHON DEVICE. 3. PROVIDE 1/4" SUCTION TUBING, 9/16" INLET HOSE AND DRAIN CONNECTOR KIT. 4. INSTALL PUMP IN ACCESSIBLE LOCATION.						

SPLIT SYSTEM HEAT PUMP SCHEDULE			[ADD ALTERNATE SCOPE OF WORK]								
TAG	DESCRIPTION	AREA SERVED	MAKE & MODEL	CFM	REFRIGERANT	COOLING CAP.	HEATING CAP.	ELECTRICAL	M.C.A.	CONDENSING UNIT	NOTES
(U-3.0)	WALL MOUNTED HEAT PUMP	TELECOM OFFICE	DAIKIN FTXS12LVJU	403	R-410A	12,000 BTU/HR	14,400 BTU/HR	208V/1P	-	(U-4)	1,2,3,4,5,6
◆ NOTES: 1. FURNISH AND INSTALL ALL LIQUID/SUCTION PIPING BETWEEN EVAPORATOR AND CONDENSING UNIT. COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS. 2. EACH UNIT TO BE EQUIPPED WITH INTEGRAL CONDENSATE LIFT PUMP. 3. NOMINAL COOLING CAPACITIES BASED ON FOLLOWING CONDITIONS: 80°F DB/ 67°F WB (INDOOR). 4. NOMINAL HEATING CAPACITIES BASED ON FOLLOWING CONDITIONS: 70°F DB/ 60° WB (INDOOR). 5. UNIT TO BE EQUIPPED WITH CONDENSATE DRAIN PIPE ASSEMBLY. 6. INDOOR UNIT IS POWERED BY THE OUTDOOR UNIT.											
TAG	DESCRIPTION	MAKE & MODEL	REFRIGERANT	CAPACITY BTU/HR	SEER COOLING	COP HEATING	TEMP. RANGE	ELECTRICAL	M.C.A.	MAX BRK.	NOTES
(U-3)	"OUTDOOR" CONDENSING UNIT	DAIKIN RXS12LVJU	R-410A	12,000 COOLING	23	4.35	5-115°F	208V/1P	8.75	15 AMP	1 2
◆ NOTES: 1. FURNISH AND INSTALL ALL LIQUID/SUCTION PIPING BETWEEN EVAPORATOR UNIT AND CONDENSING UNIT. COORDINATE PIPE SIZING AND ROUTING WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS. 2. UNIT IS TO BE WALL MOUNTED IN SERVER ROOM AS INDICATED. COORDINATE EXACT LOCATION WITH OWNER PRIOR TO INSTALLATION. PROVIDE FABRICATED STRUCTURAL SUPPORT FOR EQUIPMENT. ENSURE UNIT IS INSTALLED TO COMPLY WITH MANUFACTURER'S REQUIREMENTS.											

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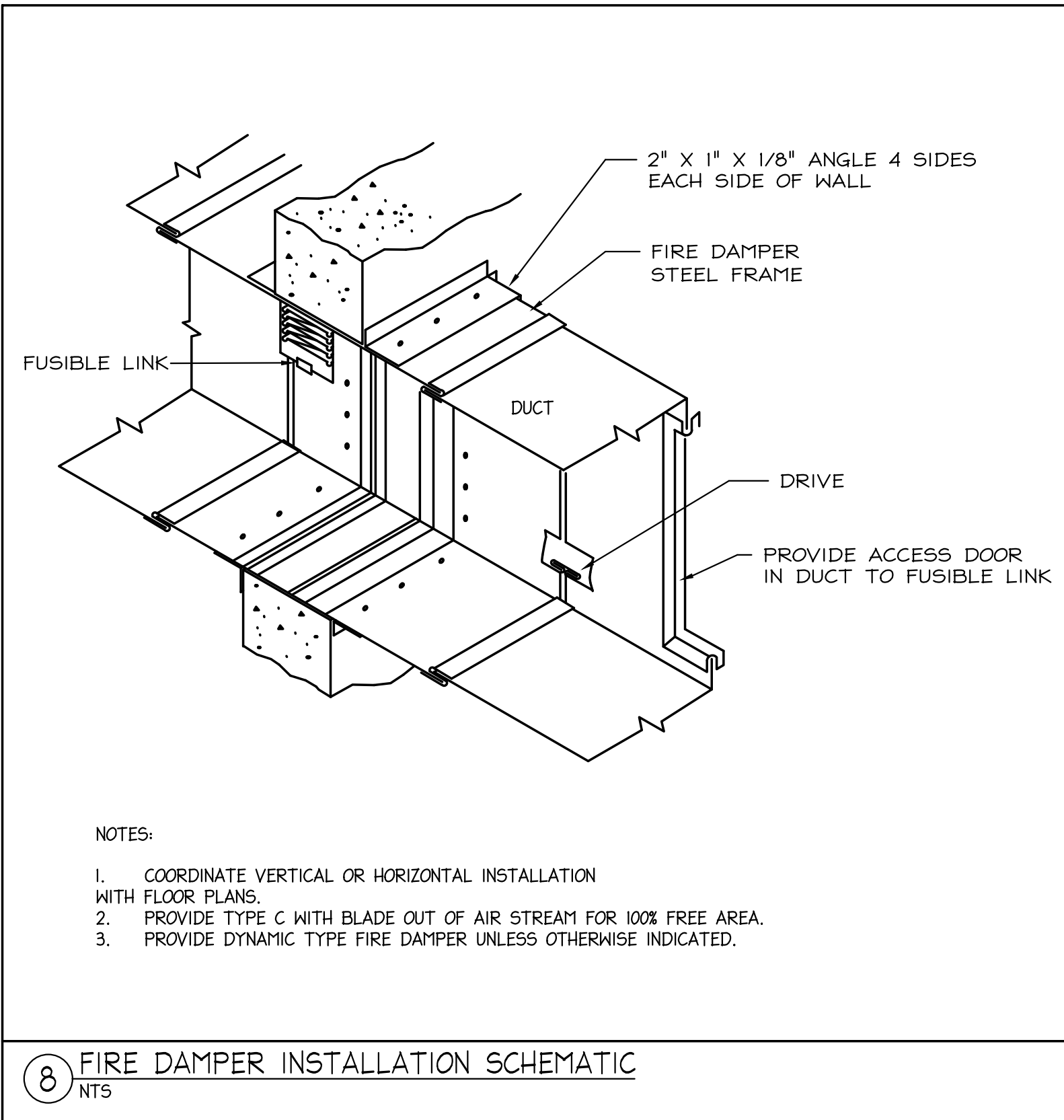
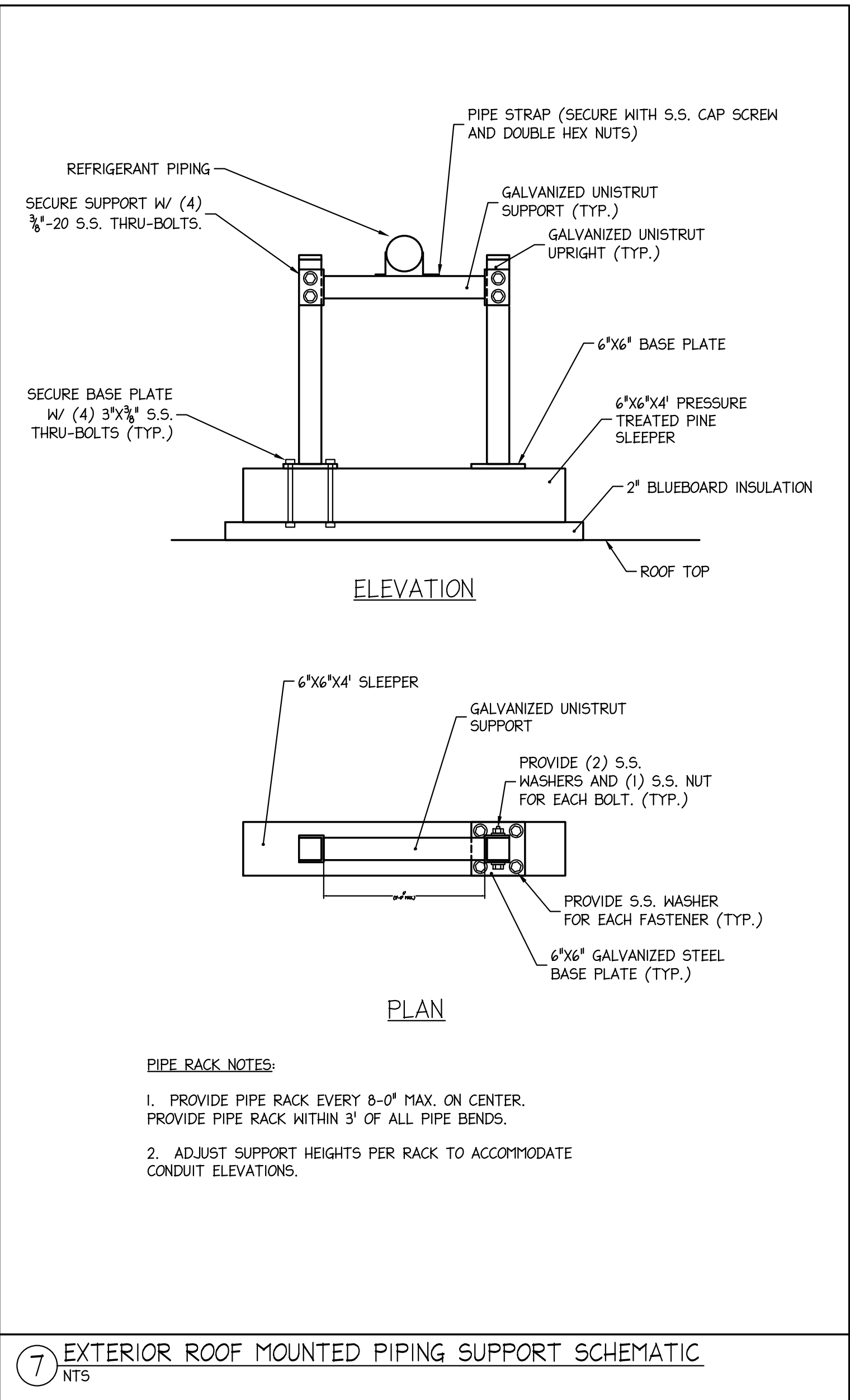
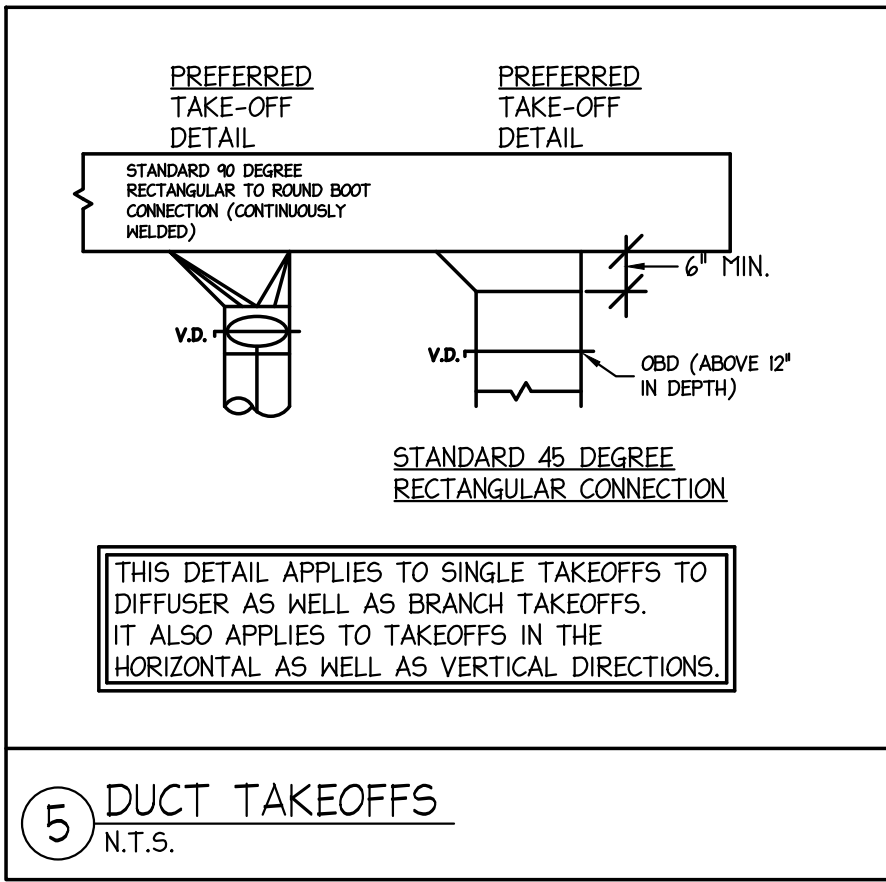
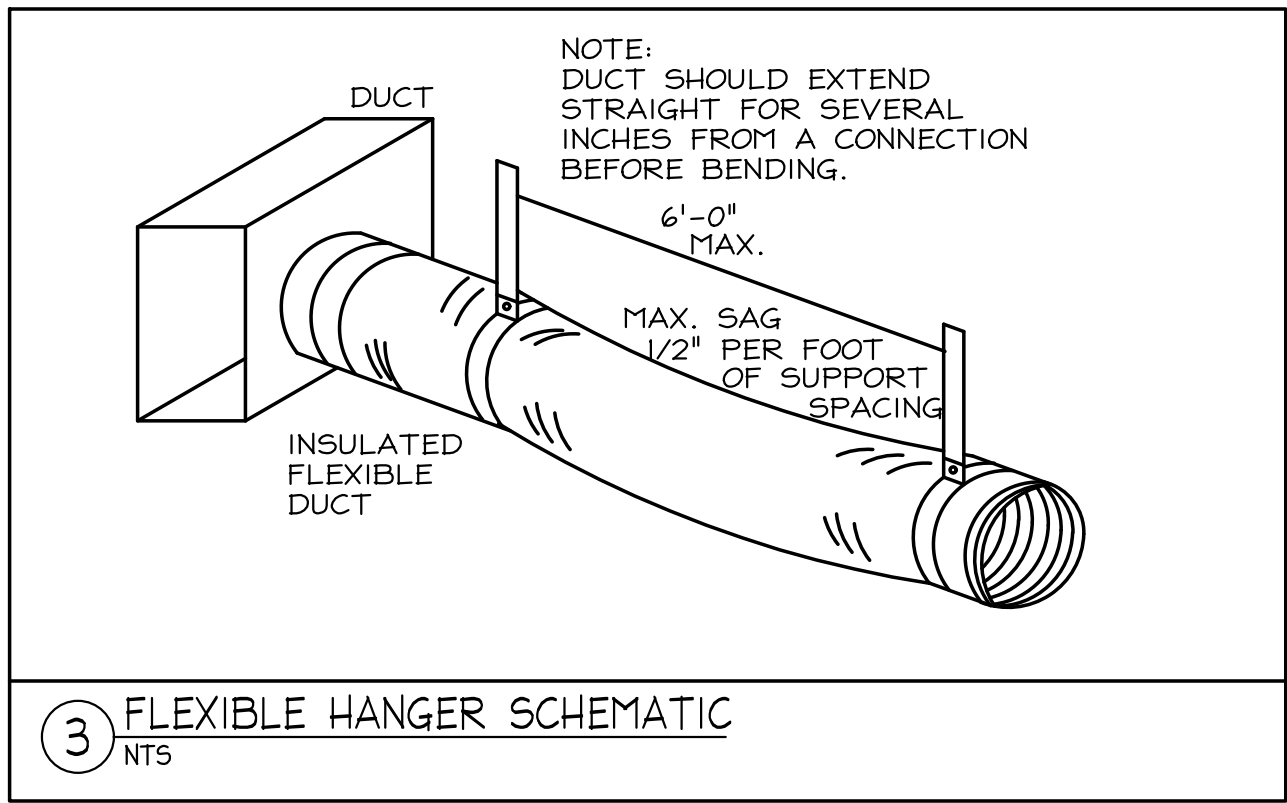
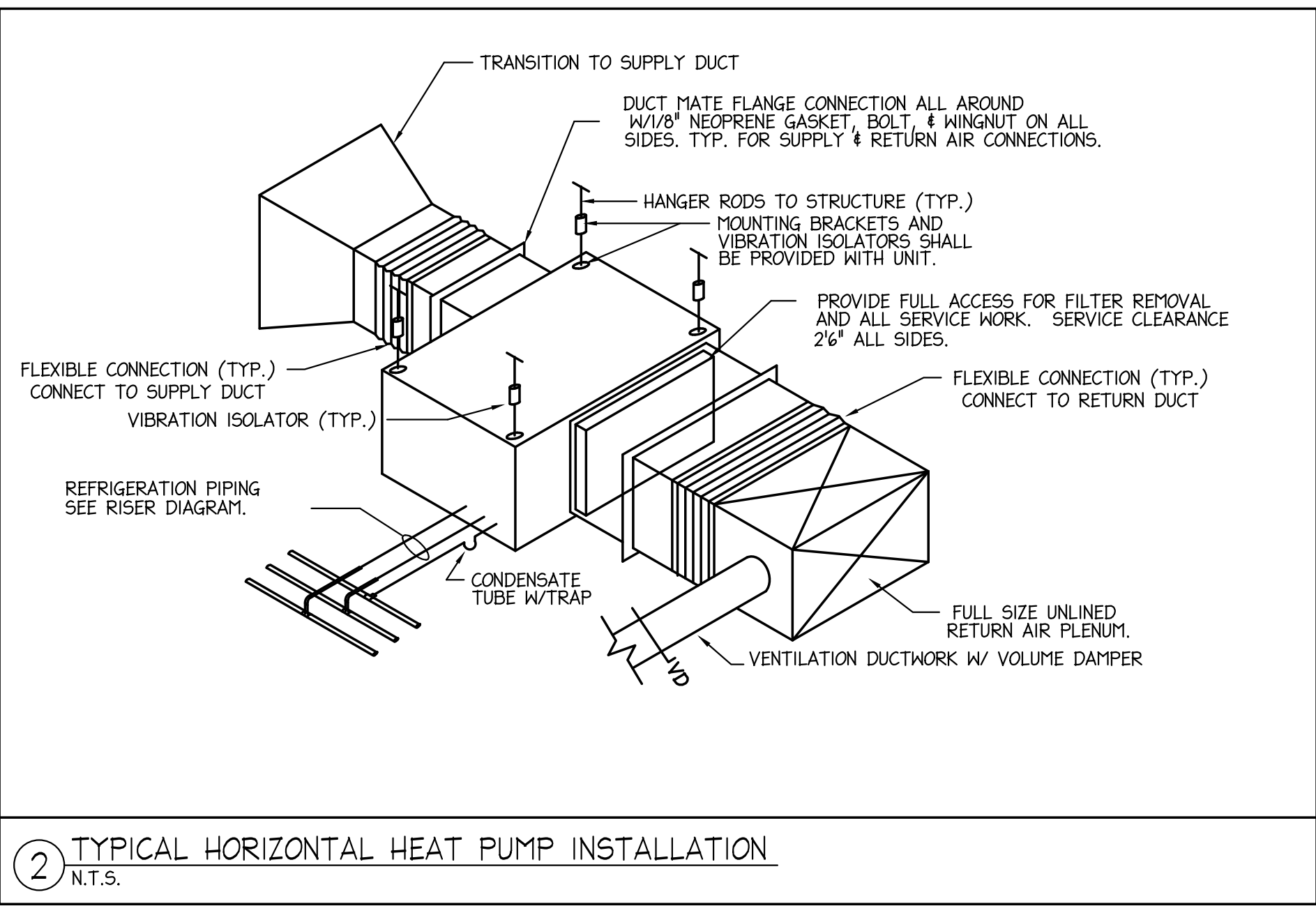
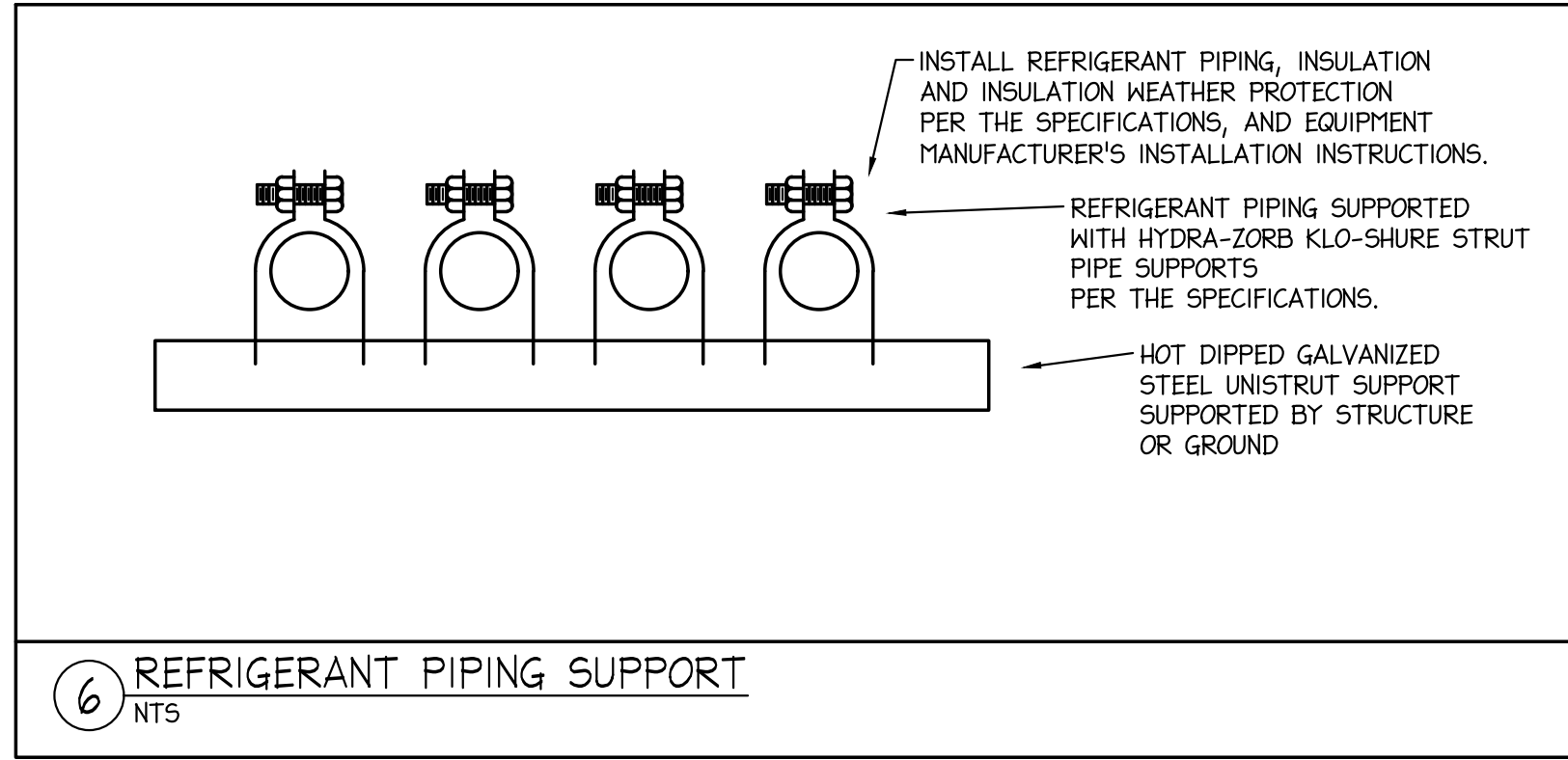
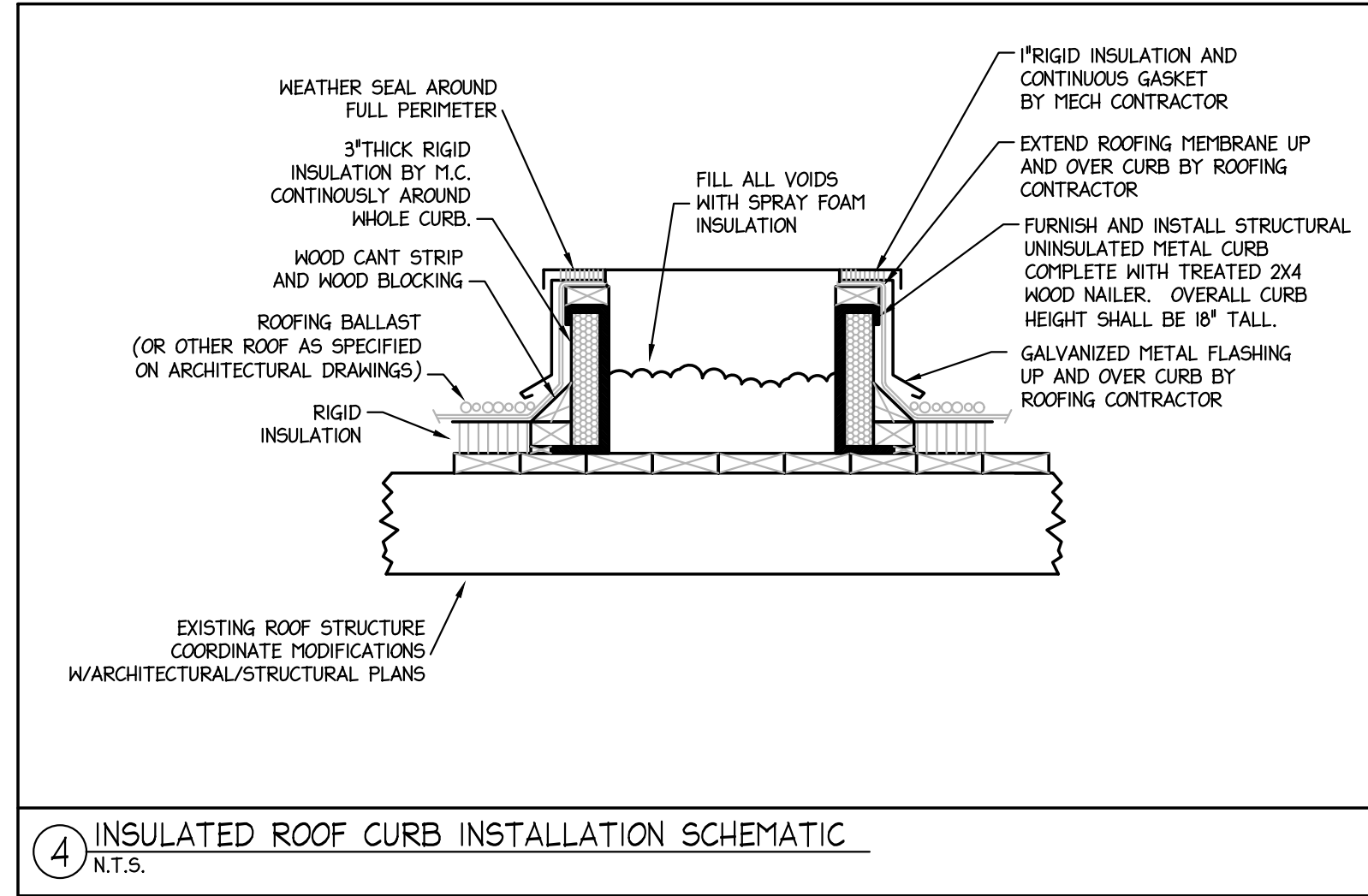
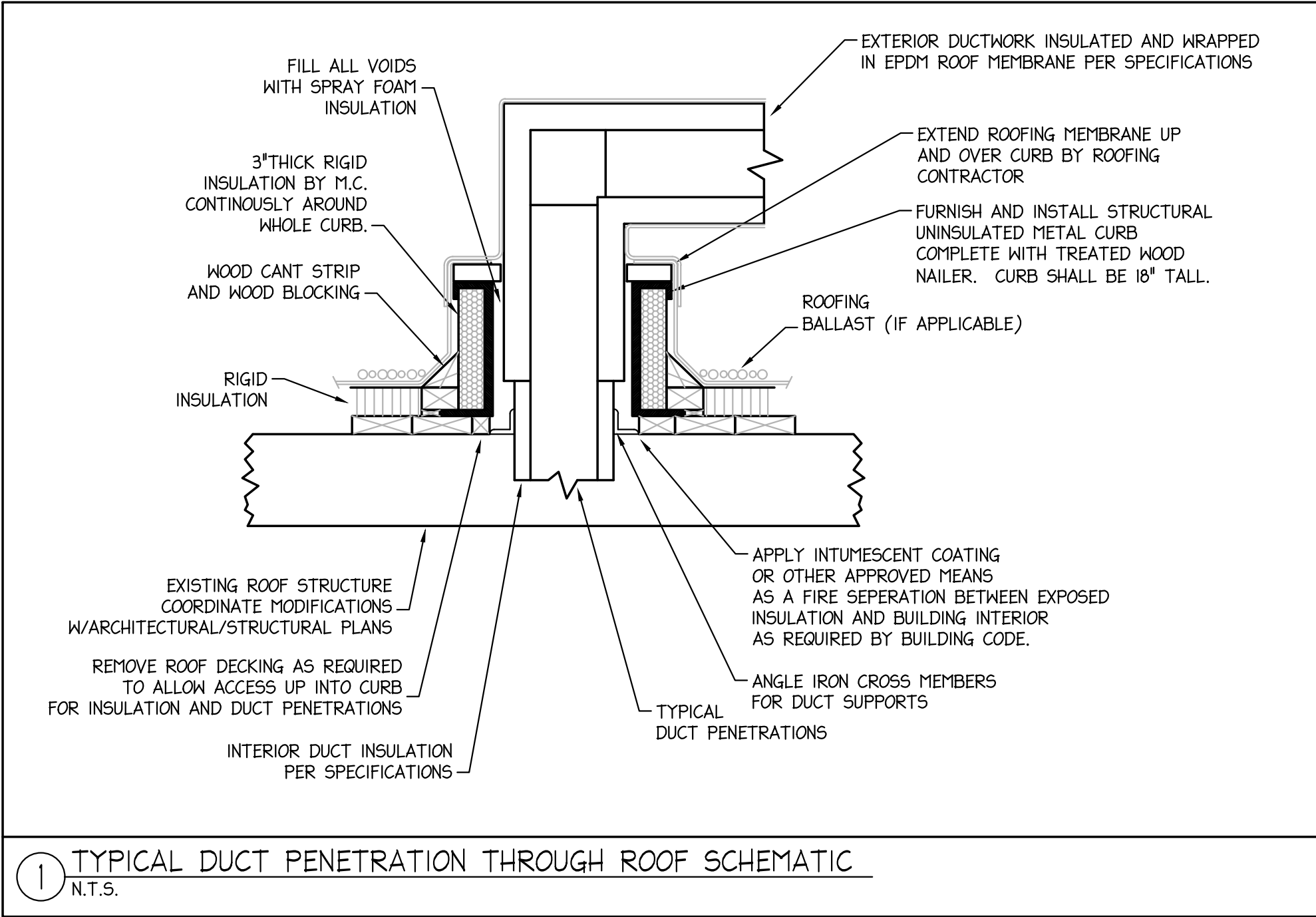


200 CHURCH STREET
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NO.	DATE	REVISION
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MECHANICAL
SCHEDULES

M5.03



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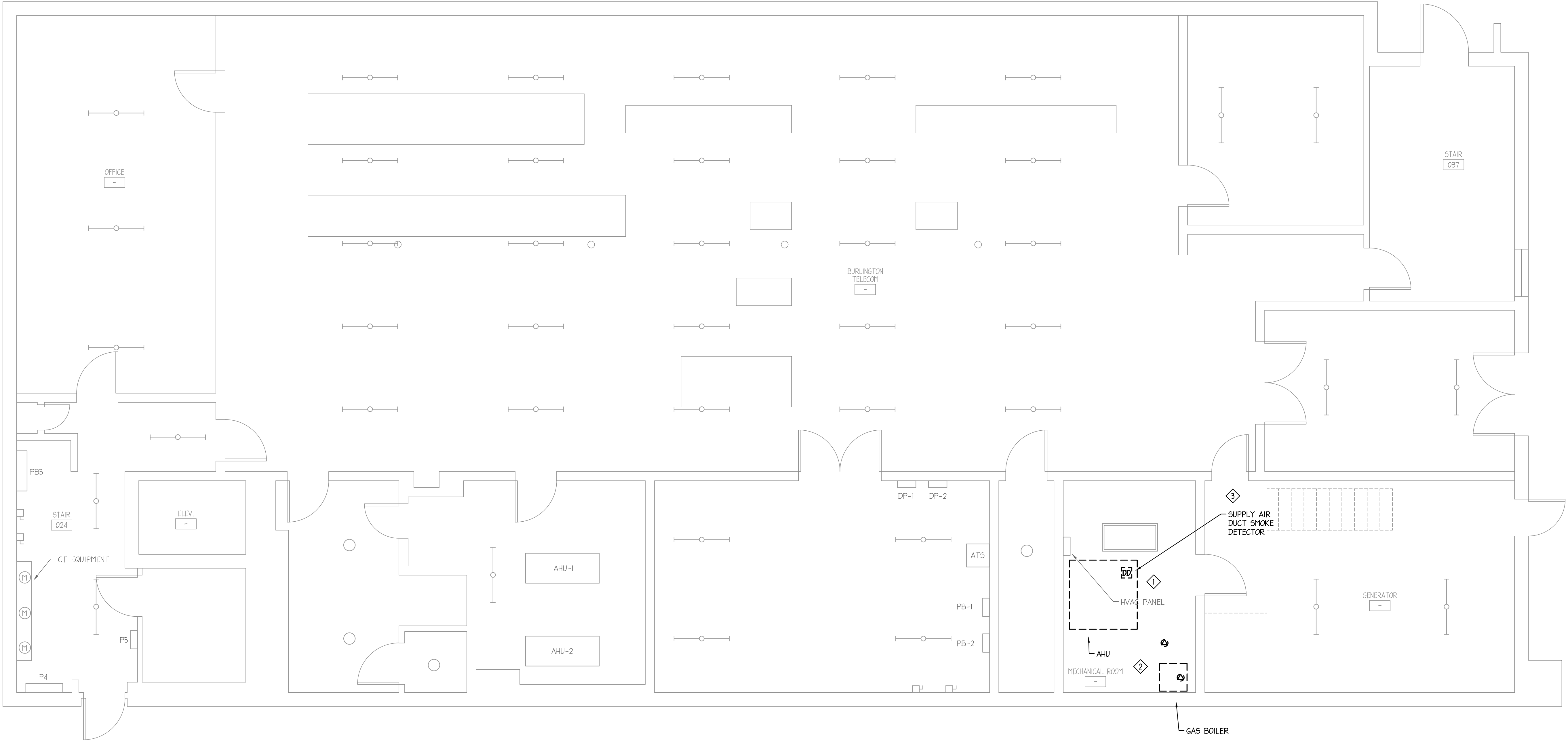
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200 CHURCH STREET
BURLINGTON, VERMONT

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PROJECT #:	21201	
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DATE:	8/17/2022	
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MECHANICAL
DETAILS

M6.01



ELECTRICAL GENERAL NOTES:

1. CONTRACTOR TO WORK AROUND EXISTING LIGHT FIXTURES, IF NECESSARY CAREFULLY REMOVE AND STORE DURING CONSTRUCTION OR TEMPORARILY SUPPORT AND PROTECT LIGHT FIXTURES AS REQUIRED DURING CONSTRUCTION.
2. COORDINATE ALL SHUTDOWNS OF THE ELECTRICAL SYSTEMS AND CIRCUIT BREAKERS WITH OWNER AND FACILITY MANAGER PRIOR TO ANY DEMOLITION OR NEW WORK.
3. THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
4. THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

ELECTRICAL DEMOLITION LEGEND	
-----	EXISTING MECHANICAL TO BE DEMOLISHED
—————	EXISTING MECHANICAL TO REMAIN

ELECTRICAL SPECIFIC DEMOLITION NOTES:

1. DEMOLISH EXISTING MECHANICAL EQUIPMENT POWER FEEDS BACK TO LAST ACTIVE BRANCH OR CIRCUIT BREAKER IF DEDICATED CIRCUIT.
2. DEMOLISH EXISTING BOILER ELECTRICAL FEED, ASSOCIATED HOT WATER PUMP POWER FEEDS, AND ELECTRICAL SAFETY DEVICES.
3. PROVIDE THE SERVICES OF A FIRE ALARM CONTRACTOR TO REMOVE EXISTING DUCT SMOKE DETECTOR AND UPDATE FIRE ALARM SYSTEM PROGRAMMING TO REFLECT FIRE ALARM SYSTEM REVISIONS.

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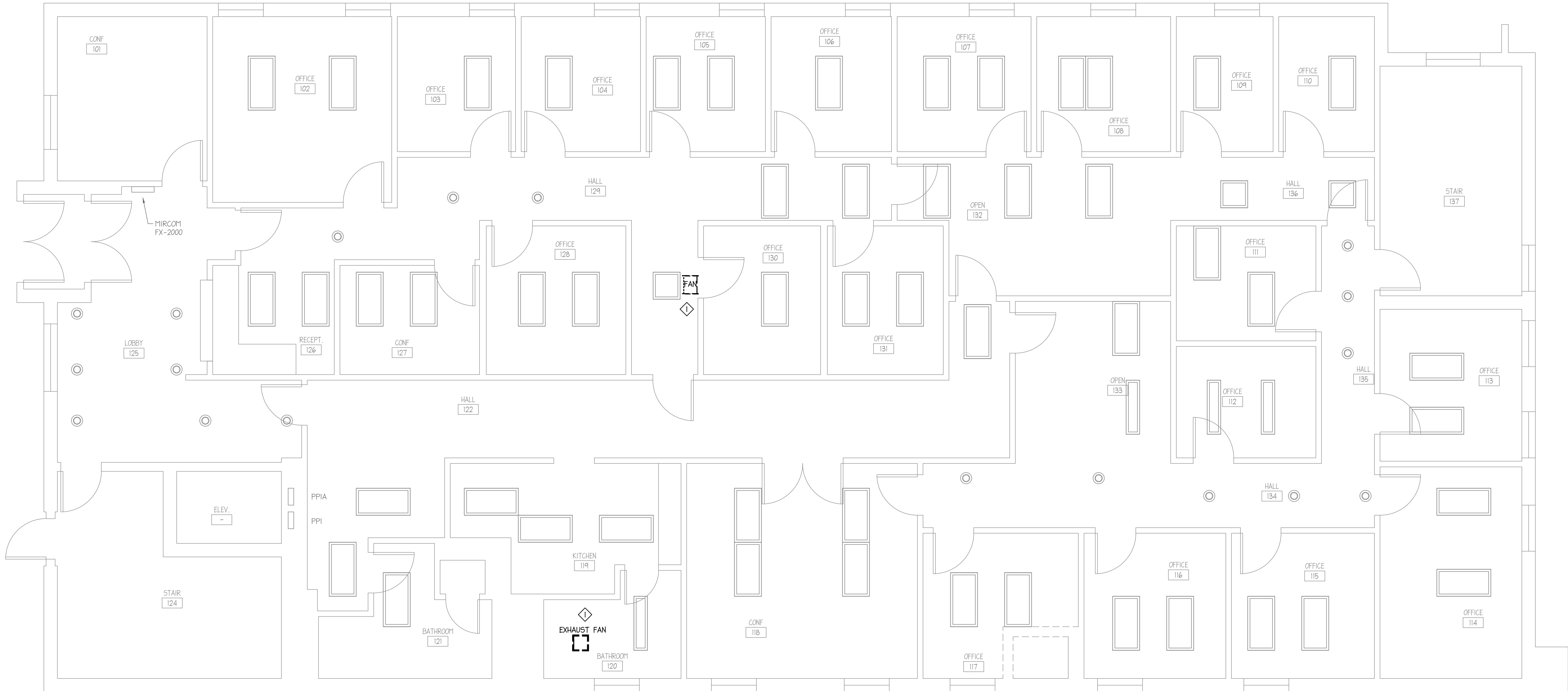
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BASEMENT
ELECTRICAL
DEMOLITION PLAN

E0.01



200 CHURCH STREET
BURLINGTON, VERMONT



ELECTRICAL GENERAL NOTES:

1. CONTRACTOR TO WORK AROUND EXISTING LIGHT FIXTURES, IF NECESSARY CAREFULLY REMOVE AND STORE DURING CONSTRUCTION OR TEMPORARILY SUPPORT AND PROTECT LIGHT FIXTURES AS REQUIRED DURING CONSTRUCTION.
2. COORDINATE ALL SHUTDOWNS OF THE ELECTRICAL SYSTEMS AND CIRCUIT BREAKERS WITH OWNER AND FACILITY MANAGER PRIOR TO ANY DEMOLITION OR NEW WORK.
3. THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
4. THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

ELECTRICAL DEMOLITION LEGEND	
-----	EXISTING MECHANICAL TO BE DEMOLISHED
—————	EXISTING MECHANICAL TO REMAIN

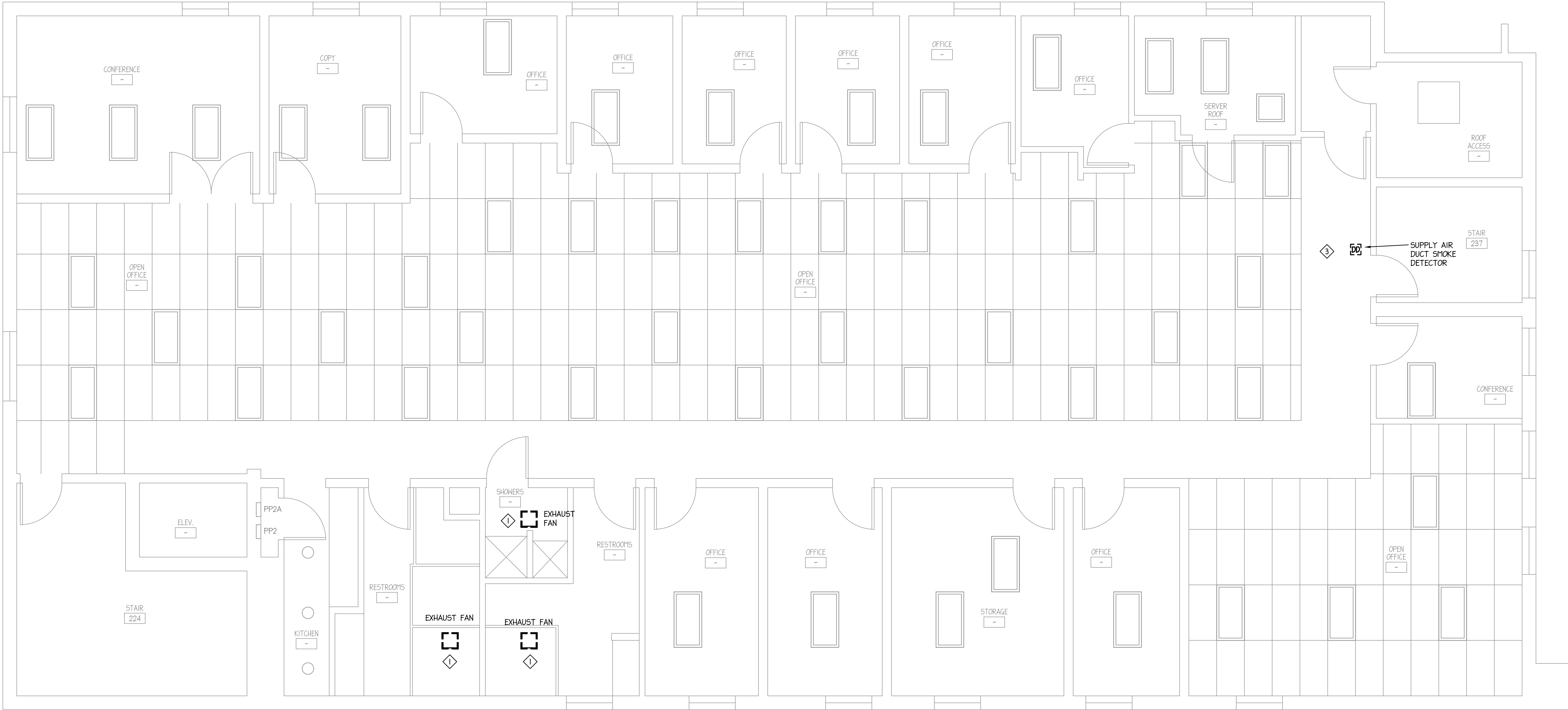
ELECTRICAL SPECIFIC DEMOLITION NOTES:

1. DEMOLISH EXISTING MECHANICAL EQUIPMENT POWER FEEDS BACK TO LAST ACTIVE BRANCH OR CIRCUIT BREAKER IF DEDICATED CIRCUIT.
2. DEMOLISH EXISTING BOILER ELECTRICAL FEED, ASSOCIATED HOT WATER PUMP POWER FEEDS, AND ELECTRICAL SAFETY DEVICES.
3. PROVIDE THE SERVICES OF A FIRE ALARM CONTRACTOR TO REMOVE EXISTING DUCT SMOKE DETECTOR AND UPDATE FIRE ALARM SYSTEM PROGRAMMING TO REFLECT FIRE ALARM SYSTEM REVISIONS.

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FIRST FLOOR
ELECTRICAL
DEMOLITION PLAN



ELECTRICAL GENERAL NOTES:

1. CONTRACTOR TO WORK AROUND EXISTING LIGHT FIXTURES, IF NECESSARY CAREFULLY REMOVE AND STORE DURING CONSTRUCTION OR TEMPORARILY SUPPORT AND PROTECT LIGHT FIXTURES AS REQUIRED DURING CONSTRUCTION.
2. COORDINATE ALL SHUTDOWNS OF THE ELECTRICAL SYSTEMS AND CIRCUIT BREAKERS WITH OWNER AND FACILITY MANAGER PRIOR TO ANY DEMOLITION OR NEW WORK.
3. THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
4. THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

ELECTRICAL DEMOLITION LEGEND

- EXISTING MECHANICAL TO BE DEMOLISHED
————— EXISTING MECHANICAL TO REMAIN

◆ ELECTRICAL SPECIFIC DEMOLITION NOTES:

1. DEMOLISH EXISTING MECHANICAL EQUIPMENT POWER FEEDS BACK TO LAST ACTIVE BRANCH OR CIRCUIT BREAKER IF DEDICATED CIRCUIT.
2. DEMOLISH EXISTING BOILER ELECTRICAL FEED, ASSOCIATED HOT WATER PUMP POWER FEEDS, AND ELECTRICAL SAFETY DEVICES.
3. PROVIDE THE SERVICES OF A FIRE ALARM CONTRACTOR TO REMOVE EXISTING DUCT SMOKE DETECTOR AND UPDATE FIRE ALARM SYSTEM PROGRAMMING TO REFLECT FIRE ALARM SYSTEM REVISIONS.

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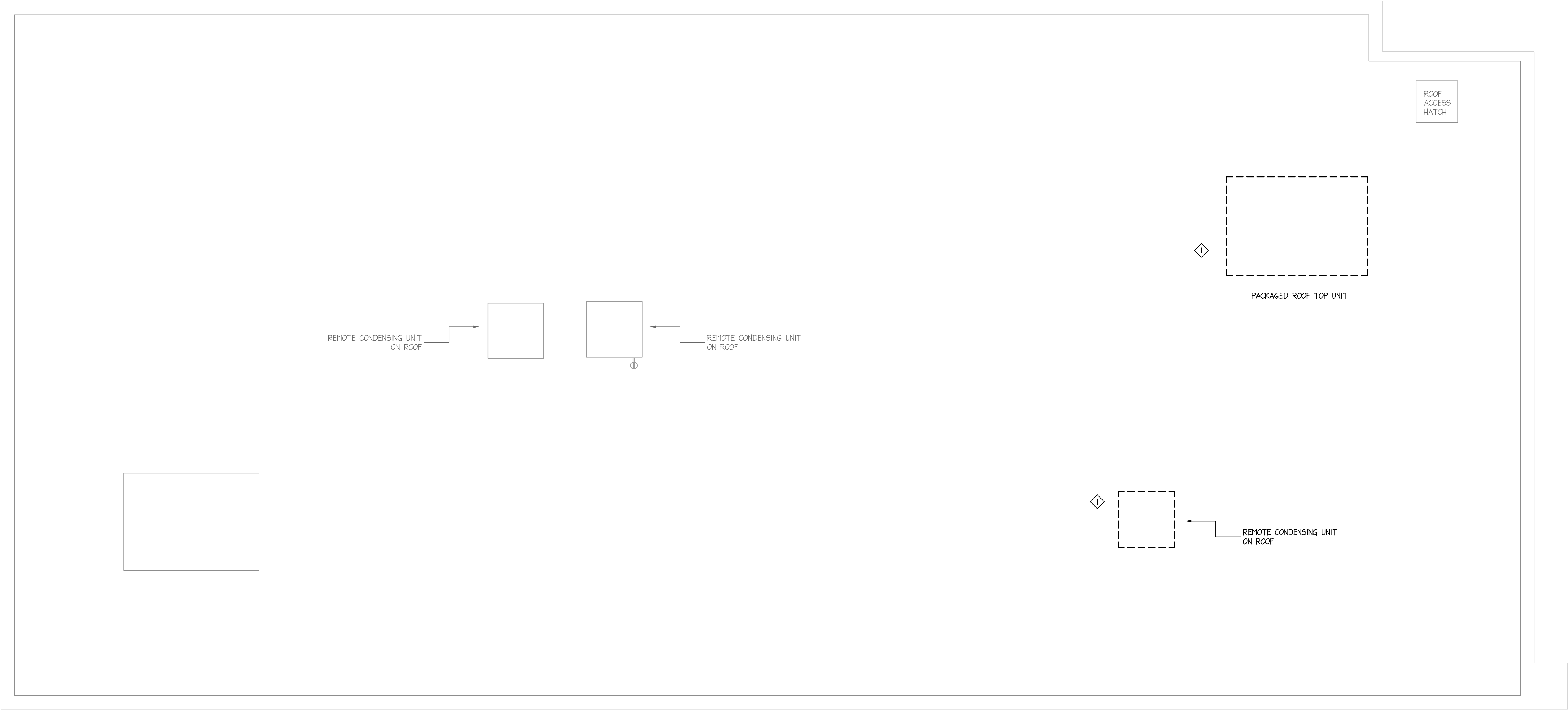
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SECOND FLOOR
ELECTRICAL
DEMOLITION PLAN

E0.21



ELECTRICAL DEMOLITION LEGEND	
-----	EXISTING MECHANICAL TO BE DEMOLISHED
—————	EXISTING MECHANICAL TO REMAIN

- ◆ ELECTRICAL SPECIFIC DEMOLITION NOTES:
- DEMOLISH EXISTING MECHANICAL EQUIPMENT POWER FEEDS BACK TO LAST ACTIVE BRANCH OR CIRCUIT BREAKER IF DEDICATED CIRCUIT.
 - DEMOLISH EXISTING BOILER ELECTRICAL FEED, ASSOCIATED HOT WATER PUMP POWER FEEDS, AND ELECTRICAL SAFETY DEVICES.
 - PROVIDE THE SERVICES OF A FIRE ALARM CONTRACTOR TO REMOVE EXISTING DUCT SMOKE DETECTOR AND UPDATE FIRE ALARM SYSTEM PROGRAMMING TO REFLECT FIRE ALARM SYSTEM REVISIONS.

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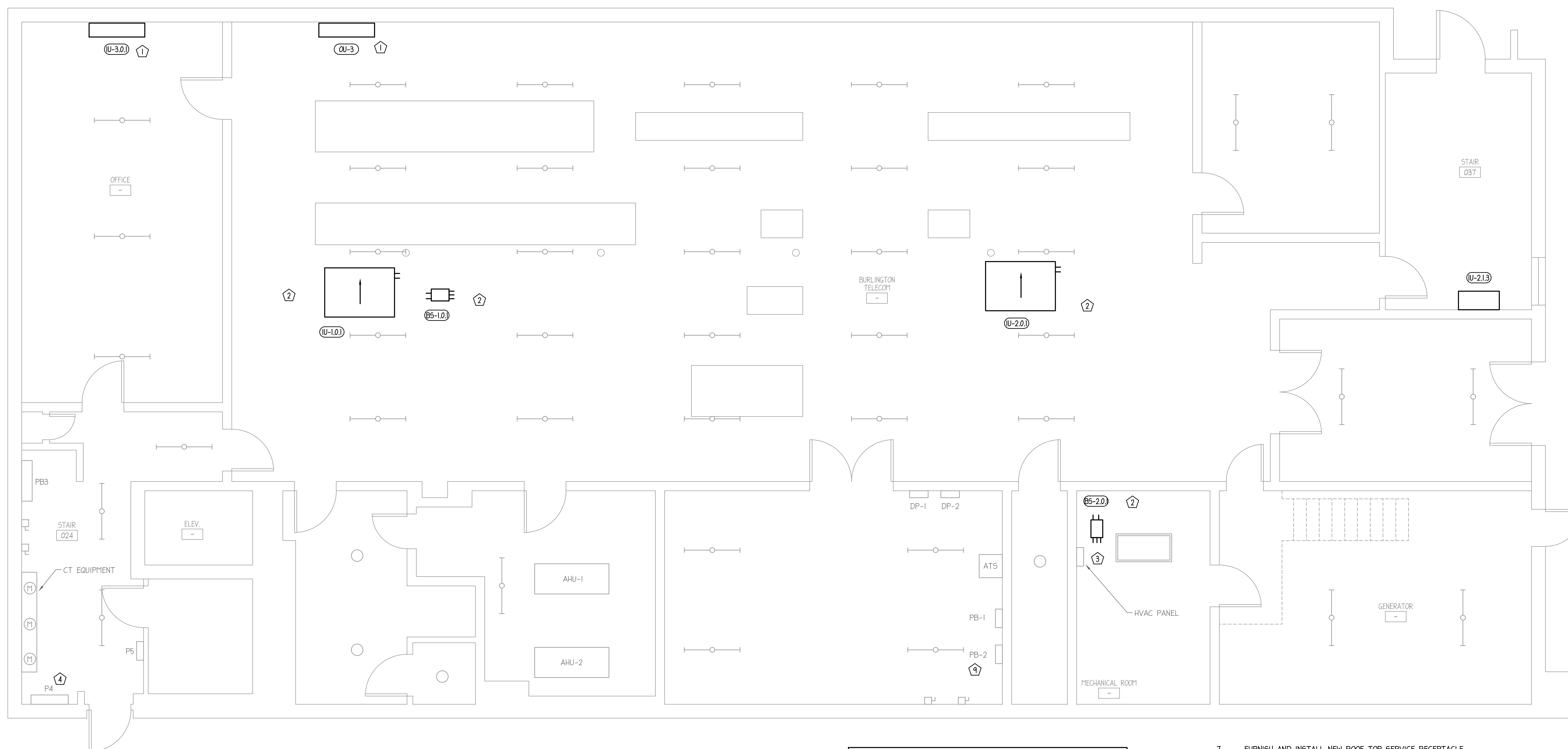
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ROOF LEVEL
ELECTRICAL
DEMOLITION PLAN

E0.31

LN
CONSULTING

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BURLINGTON, VERMONT



NEW MECHANICAL TO BE FURNISHED AND INSTALLED
EXISTING MECHANICAL TO REMAIN

1. PROVIDE AD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDE ELECTRICAL WORK.
2. PROVIDE AD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR UNITS, BRANCH SELECTOR UNITS, AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDED ELECTRICAL WORK.
3. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "HVA-C" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
4. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "P4" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
5. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PPI" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
6. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "P22" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

1. CONTRACTOR TO WORK AROUND EXISTING LIGHT FIXTURES, IF NECESSARY CAREFULLY REMOVE AND STORE DURING CONSTRUCTION OR TEMPORARILY SUPPORT AND PROTECT LIGHT FIXTURES AS REQUIRED DURING CONSTRUCTION.
2. COORDINATE ALL SHUTDOWNS OF THE ELECTRICAL SYSTEMS AND CIRCUIT BREAKERS WITH OWNER AND FACILITY MANAGER PRIOR TO ANY DEMOLITION OR NEW WORK.
3. THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
4. THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRIC, MECHANICAL, AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

7. FURNISH AND INSTALL NEW ROOF TOP SERVICE RECEPTACLE.
8. PROVIDE GFCI PROTECTED DEVICE WITH WEATHER PROOF COVER. FEED FROM EXISTING ROOF TOP CIRCUIT.
9. ELECTRICAL CIRCUIT TO BE ROUTED THROUGH PROPOSED PITCH POCKET. COORDINATE LOCATION OF ELECTRICAL FEED ROOF PENETRATION WITH GENERAL TRADES CONTRACTOR.
10. PERFORM ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL PB-2 PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN TO EXISTING ELECTRICAL EQUIPMENT BASECABINET. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

NO.	DATE	REVISION
PROJECT #:		21201
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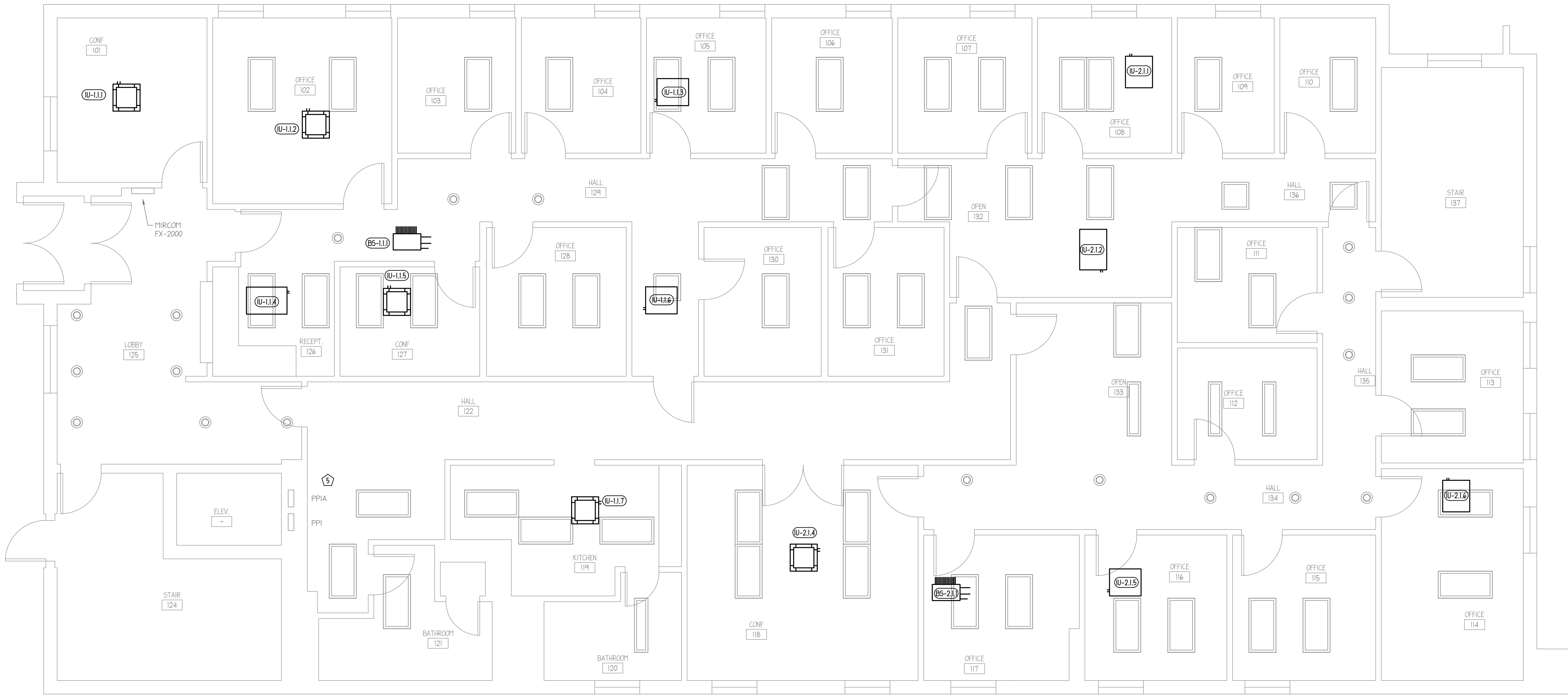
BASEMENT
ELECTRICAL
NEW WORK PLAN

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ELECTRICAL GENERAL NOTES:

1. CONTRACTOR TO WORK AROUND EXISTING LIGHT FIXTURES, IF NECESSARY CAREFULLY REMOVE AND STORE DURING CONSTRUCTION OR TEMPORARILY SUPPORT AND PROTECT LIGHT FIXTURES AS REQUIRED DURING CONSTRUCTION.
2. COORDINATE ALL SHUTDOWNS OF THE ELECTRICAL SYSTEMS AND CIRCUIT BREAKERS WITH OWNER AND FACILITY MANAGER PRIOR TO ANY DEMOLITION OR NEW WORK.
3. THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
4. THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

ELECTRICAL NEW WORK LEGEND

- NEW MECHANICAL TO BE FURNISHED AND INSTALLED
- EXISTING MECHANICAL TO REMAIN

ELECTRICAL SPECIFIC NEW WORK NOTES:

1. PROVIDE ADD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDE ELECTRICAL WORK.
2. PROVIDE ADD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR UNITS, BRANCH SELECTOR UNITS, AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDED ELECTRICAL WORK.
3. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "HVAC" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
4. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "P4" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
5. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PP1" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
6. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PP2" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

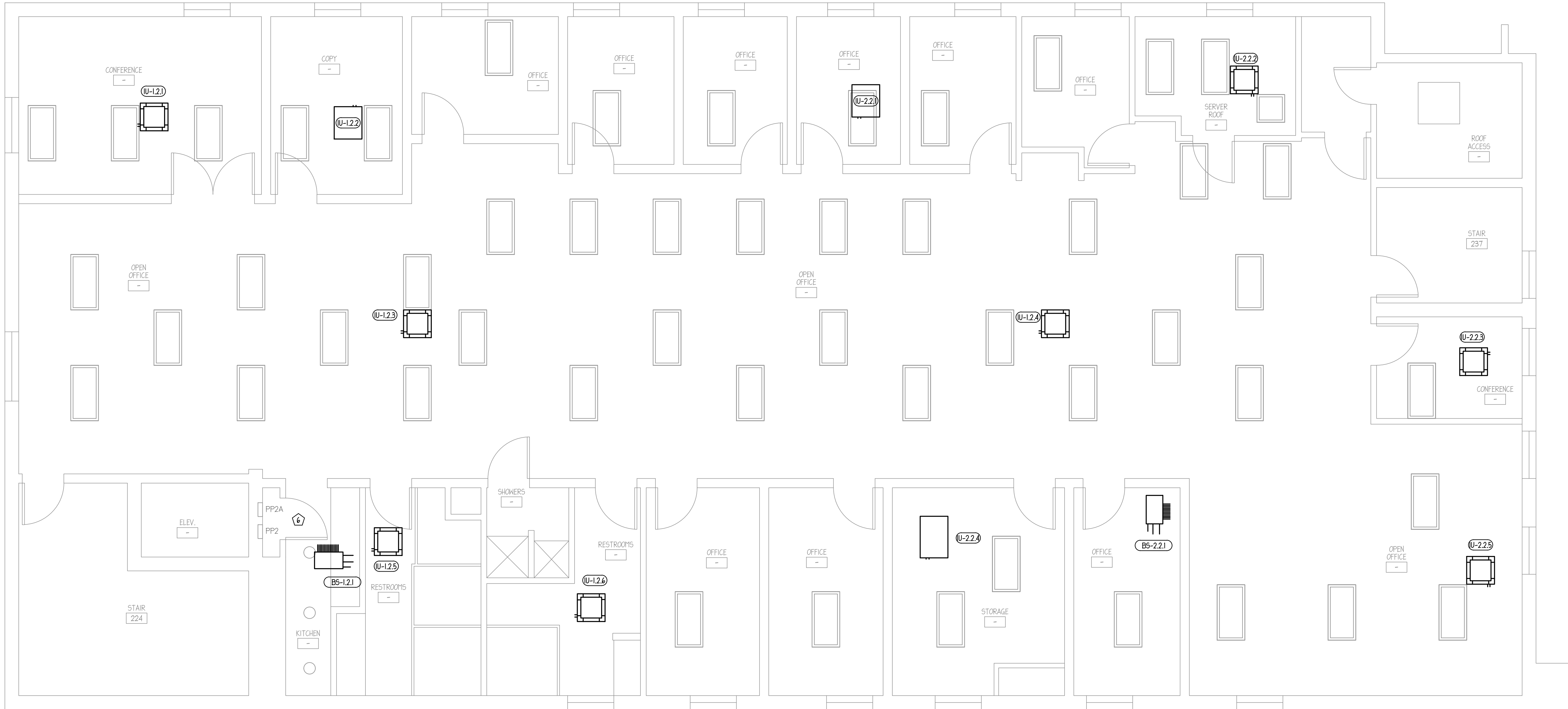
7. FURNISH AND INSTALL NEW ROOF TOP SERVICE RECEPTACLE. PROVIDE GFCI PROTECTED DEVICE WITH WEATHER PROOF COVER. FEED FROM EXISTING ROOF TOP CIRCUIT.
8. ELECTRICAL CIRCUIT TO BE ROUTED THROUGH PROPOSED PITCH POCKET. COORDINATE LOCATION OF ELECTRICAL FEED ROOF PENETRATION WITH GENERAL TRADES CONTRACTOR.
9. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PB-2" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

NO.	DATE	REVISION

PROJECT #:	21201
DRAWN:	ARW
CHECKED:	GDM
DATE:	8/17/2022
SCALE:	1/4" = 1'-0"

FIRST FLOOR
ELECTRICAL
NEW WORK PLAN

E1.11



ELECTRICAL GENERAL NOTES:

- CONTRACTOR TO WORK AROUND EXISTING LIGHT FIXTURES, IF NECESSARY CAREFULLY REMOVE AND STORE DURING CONSTRUCTION OR TEMPORARILY SUPPORT AND PROTECT LIGHT FIXTURES AS REQUIRED DURING CONSTRUCTION.
- COORDINATE ALL SHUTDOWNS OF THE ELECTRICAL SYSTEMS AND CIRCUIT BREAKERS WITH OWNER AND FACILITY MANAGER PRIOR TO ANY DEMOLITION OR NEW WORK.
- THE BUILDING WILL BE OCCUPIED THROUGHOUT THE CONSTRUCTION DURATION. AREAS AND SYSTEMS OUTSIDE THE IMMEDIATE SCOPE OF WORK SHALL REMAIN OPERATIONAL DURING CONSTRUCTION.
- THE BURLINGTON TELECOM AREAS INCLUDING BUT NOT LIMITED TO ELECTRICAL, MECHANICAL AND PLUMBING SYSTEMS SHALL REMAIN OPERATIONAL DURING CONSTRUCTION. DEMOLITION AND PROPOSED SCOPE OF WORK SHALL BE COORDINATED WITH BURLINGTON TELECOM FOR ACCESS TO SPACE.

ELECTRICAL NEW WORK LEGEND	
	NEW MECHANICAL TO BE FURNISHED AND INSTALLED
	EXISTING MECHANICAL TO REMAIN

ELECTRICAL SPECIFIC NEW WORK NOTES:

- PROVIDE ADD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDE ELECTRICAL WORK.
- PROVIDE ADD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR UNITS, BRANCH SELECTOR UNITS, AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDED ELECTRICAL WORK.
- PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "HVAC" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
- PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "P4" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
- PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PP1" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
- PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PP2" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

- FURNISH AND INSTALL NEW ROOF TOP SERVICE RECEPTACLE. PROVIDE GFCI PROTECTED DEVICE WITH WEATHER PROOF COVER. FEED FROM EXISTING ROOF TOP CIRCUIT.
- ELECTRICAL CIRCUIT TO BE ROUTED THROUGH PROPOSED PITCH POCKET. COORDINATE LOCATION OF ELECTRICAL FEED ROOF PENETRATION WITH GENERAL TRADES CONTRACTOR.
- PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PB-2" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

ISSUED FOR
BID
NOT FOR
CONSTRUCTION

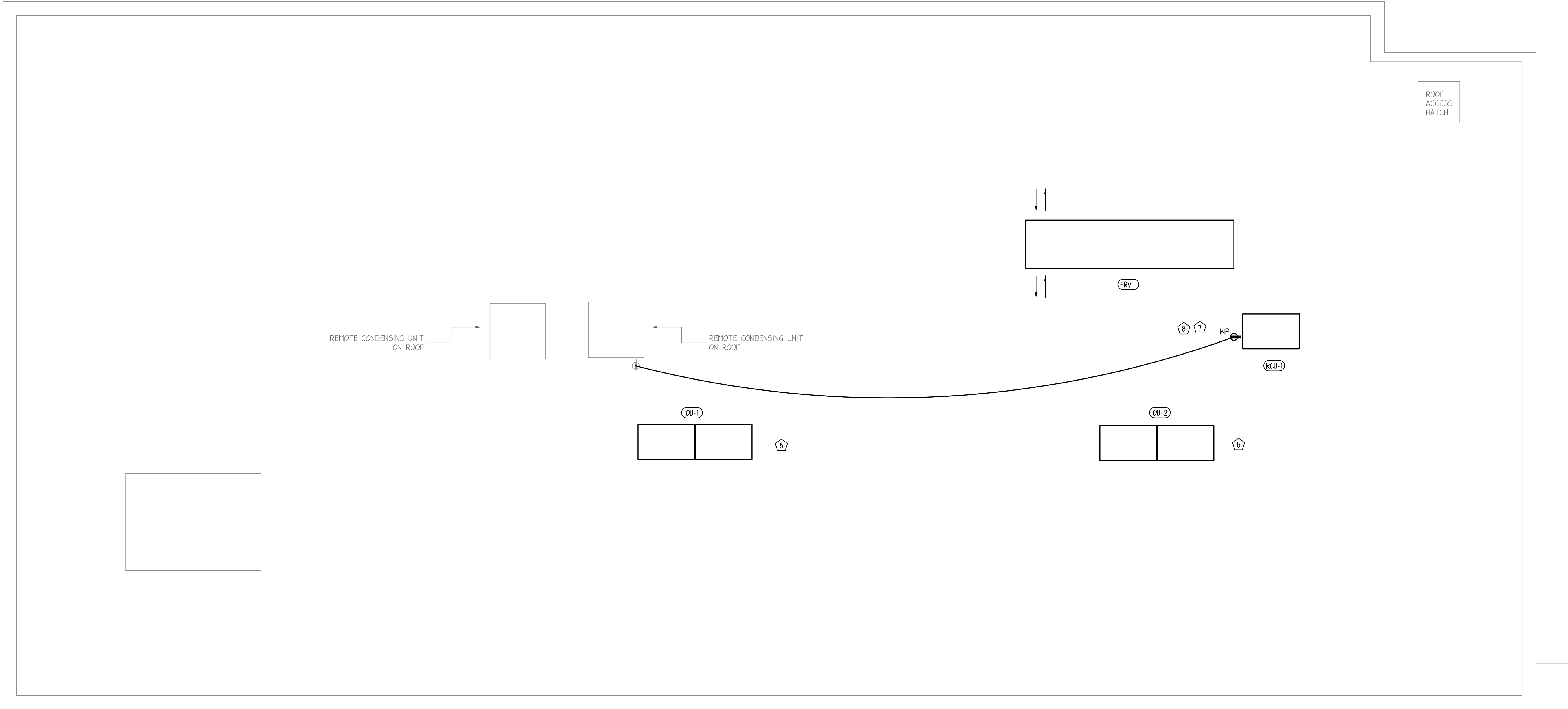


200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION
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DATE:	8/17/2022	
SCALE:	1/4" = 1'-0"	

SECOND FLOOR
ELECTRICAL
NEW WORK PLAN

E1.21



ELECTRICAL NEW WORK LEGEND	
	NEW MECHANICAL TO BE FURNISHED AND INSTALLED
	EXISTING MECHANICAL TO REMAIN

⬢ ELECTRICAL SPECIFIC NEW WORK NOTES:

1. PROVIDE ADD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDE ELECTRICAL WORK.
2. PROVIDE ADD ALTERNATE PRICING FOR SCOPE OF WORK INDICATED. PROVIDE POWER FEED FOR EQUIPMENT AND POWER AND CONTROL WIRING BETWEEN INDOOR UNITS, BRANCH SELECTOR UNITS, AND OUTDOOR UNITS. BASE BID PRICING SHALL NOT INCLUDED ELECTRICAL WORK.
3. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "P4" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
4. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "P4" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
5. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PP1" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.
6. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PP2" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

7. FURNISH AND INSTALL NEW ROOF TOP SERVICE RECEPTACLE. PROVIDE GFCI PROTECTED DEVICE WITH WEATHER PROOF COVER. FEED FROM EXISTING ROOF TOP CIRCUIT.
8. ELECTRICAL CIRCUIT TO BE ROUTED THROUGH PROPOSED PITCH POCKET. COORDINATE LOCATION OF ELECTRICAL FEED ROOF PENETRATION WITH GENERAL TRADES CONTRACTOR.
9. PROVIDE ELECTRICAL CIRCUITS BACK TO EXISTING ELECTRICAL PANEL "PB-2" PER ELECTRICAL EQUIPMENT SCHEDULES. REMOVE AND RETURN UNUSED CIRCUIT BREAKERS BACK TO OWNER. FURNISH AND INSTALL NEW CIRCUIT BREAKERS IN EXISTING PANEL TO ACCOMMODATE PROPOSED EQUIPMENT CIRCUITS.

ISSUED FOR
BID
NOT FOR
CONSTRUCTION



200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION

PROJECT #:	21201
DRAWN:	ARW
CHECKED:	GDM
DATE:	8/17/2022
SCALE:	1/4" = 1'-0"

ROOF LEVEL
ELECTRICAL
NEW WORK PLAN

E1.31

ELECTRICAL EQUIPMENT LEGEND	
SYMBOL	DESCRIPTION
	DISCONNECT SWITCH - WHERE LABELED, S = SWITCH SIZE AND F= FUSE SIZE. NF = NO FUSE.
	DOUBLE THROW TRANFER SWITCH - WHERE LABELED, S = SWITCH SIZE AND F= FUSE SIZE. NF = NO FUSE.
	WALL SWITCH
	WALL SWITCH INDICATING CIRCUIT CONTROLLED TYPICAL. DIMMABLE UNLESS NOTED OTHERWISE.
	KEYED WALL SWITCH CONNECTED TO LIGATURE ALARM SYSTEM
	WALL SWITCH WITH INTEGRAL OCCUPANCY SENSOR
	OCCUPANCY SENSOR
	DAYLIGHT/PHOTO SENSOR
	CABLE TV COAX JACK. "PS" INDICATES ALSO CAT 5 CABLE FROM PATIENT STATION TO RJ-45 JACK AT TV.
	DATA OUTLET. (2) CAT6 CABLES AND (2) JACKS PER LOCATION UNLESS NOTED OTHERWISE.
	DUPLEX RECEPTACLE
	QUADPLEX RECEPTACLE
	GFCI RECEPTACLE
	SIMPLEX RECEPTACLE - NEMA L6 CONFIGURATION
	JUNCTION BOX
	TYPICAL LIGHT SCONCE, LETTER INDICATES CONTROL
	TYPICAL RECESSED CAN LIGHT, LETTER INDICATES CONTROL
	TYPICAL SURFACE ROUND LIGHT, LETTER INDICATES CONTROL
	TYPICAL WALLMOUNT LIGHT FIXTURE, LETTER INDICATES CONTROL
	TYPICAL RECESSED LIGHT FIXTURE, LETTER INDICATES CONTROL
	TYPICAL EXIT LIGHT FIXTURE
	EMERGENCY LIGHT
	HOME RUN TO PANELBOARD
	WI-FI HUBB CEILING JACK. DATA JACK WITH 10FT OF SLACK AT LOCATION INDICATED.
	DUCT SMOKE DETECTOR

ABBREVIATION	DESCRIPTION
ADO	AUTOMATIC DOOR OPENER
AF	AMPERE FRAME
AFF	ABOVE FINISHED FLOOR
AT	AMPERE TRIP
BC	BARE COPPER
BP/PP	BOILER PLANT INSTRUMENTATION PANEL
CB, C/B	CIRCUIT BREAKER
DB	DIRECT BURIAL
EC	EMPTY CONDUIT
EG	EQUIPMENT GROUND
FI	FILM ILLUMINATOR
FSS	FUSED SAFETY SWITCH
FSCP	FLAME SAFEGUARD CONTROL PANEL
GTB	GROUND TERMINAL BOX
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
LTC/P	LOCAL TEMPERATURE CONTROL PANEL
MDP	MAIN DISTRIBUTION PANEL
MLO	MAIN LUGS ONLY
NFSS	NON-FUSED SAFETY SWITCH
PBPU	PREFABRICATED BEDSIDE PATIENT POWER UNIT
POD	POWER OPERATED DAMPER
PTRV	POWER TYPE ROOF VENTILATION
RR	REMOVE AND RELOCATE
R	RELOCATED
SS	SAFETY SWITCH
W	WIRE
EM	EMERGENCY POWER

ELECTRICAL LEGEND	
	EXISTING ELECTRICAL TO BE DEMOLISHED
	EXISTING ELECTRICAL TO REMAIN
	NEW ELECTRICAL WORK TO BE PROVIDED

EQUIPMENT SCHEDULE														
TAG	DESCRIPTION	LOCATION	HP	KW	FLA/MCA	V	PH (Φ)	CONDUCTORS	GROUND	CONDUIT	BREAKER SIZE	PANEL FEED	NOTES	
BS-1.0.1	BRANCH SELECTOR BOX	SEE PLANS	-	-	0.1	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PB2-#28,30	1,2,5,6
BS-2.0.1	BRANCH SELECTOR BOX	SEE PLANS	-	-	0.1	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PB2-#28,30	1,2,5,6
BS-1.1.1	BRANCH SELECTOR BOX	SEE PLANS	-	-	0.8	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
BS-2.1.1	BRANCH SELECTOR BOX	SEE PLANS	-	-	0.8	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
BS-1.2.1	BRANCH SELECTOR BOX	SEE PLANS	-	-	0.8	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
BS-2.2.1	BRANCH SELECTOR BOX	SEE PLANS	-	-	0.6	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#12,14	1,2,4
ERV-1	ENERGY RECOVERY VENTILATOR	SEE PLANS	-	-	11.1	208	3	(3) #10	(1) #10	3/4"	20	AMPS	HVAC PANEL	1,2,3,4
U-1.0.1	V.R.V. INDOOR UNIT	SEE PLANS	-	-	9.5	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PB2-#28,30	1,2,5,6
U-2.0.1	V.R.V. INDOOR UNIT	SEE PLANS	-	-	9.5	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PB2-#28,30	1,2,5,6
U-2.1.3	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
U-3.0.1	SPLIT SYSTEM INDOOR UNIT	SEE PLANS	-	-	-	-	-	-	-	-	-	-	-	6,7
U-1.1.1	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-1.1.2	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-1.1.3	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-1.1.4	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-1.1.5	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-1.1.6	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.9	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-1.1.7	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#36,38	1,2,4
U-2.1.1	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
U-2.1.2	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
U-2.1.4	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
U-2.1.5	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
U-2.1.6	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.9	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PPI-#40,42	1,2,4
U-1.2.1	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
U-1.2.2	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
U-1.2.3	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.6	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
U-1.2.4	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
U-1.2.5	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
U-1.2.6	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#11,13	1,2,4
U-2.2.1	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#12,14	1,2,4
U-2.2.2	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#12,14	1,2,4
U-2.2.3	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.3	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#12,14	1,2,4
U-2.2.4	V.R.V. INDOOR UNIT	SEE PLANS	-	-	1.4	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#12,14	1,2,4
U-2.2.5	V.R.V. INDOOR UNIT	SEE PLANS	-	-	0.6	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PP2A-#12,14	1,2,4
OU-1	V.R.V. OUTDOOR UNIT	SEE PLANS	-	-	(2) 76.5	208	3	(3) #3	(1) #8	1 1/4"	(2) 80	AMPS	P4-#1,3,5 & #2,4,6	1,2,3,4
OU-2	V.R.V. OUTDOOR UNIT	SEE PLANS	-	-	(2) 76.5	208	3	(3) #3	(1) #8	1 1/4"	(2) 80	AMPS	P4-#7,9,11 & #8,10,12	1,2,3,4
OU-3	SPLIT SYSTEM OUTDOOR UNIT	SEE PLANS	-	-	8.75	208	1	(2) #12	(1) #12	1/2"	15	AMPS	PB2-#27,29	1,2,4,6
RCU-1	ERV OUTDOOR UNIT	SEE PLANS	-	-	32.0	208	3	(3) #8	(1) #10	1"	50	AMPS	PANEL HVAC	1,2,3,4,6

GENERAL NOTES:
1. REFER TO ALL EQUIPMENT SUBMITTALS FOR FINAL CIRCUITING AND CONNECTION REQUIREMENTS.
2. ALL CIRCUITING BASED ON COPPER CONDUCTORS. SEE SPECIFICATION FOR ALUMINUM CONDUCTOR SUBSTITUTION.
3. FURNISH AND INSTALL NEW CIRCUIT BREAKER IN EXISTING PANEL. COORDINATE CIRCUIT BREAKER SIZE WITH APPROVED EQUIPMENT SHOP DRAWINGS. RECONFIGURATION OF EXISTING CIRCUITS AND BREAKERS MAY BE REQUIRED TO ACCOMMODATE MULTI-POLE BREAKERS. COORDINATE SPECIFIC REQUIREMENTS AT EACH PANEL WITH EXISTING AND PROPOSED CONDITIONS.

NOTES:
1. PROVIDE SINGLE POINT ELECTRICAL CONNECTION TO UNIT.
2. COORDINATE DISCONNECT OR BREAKER SIZE WITH APPROVED SHOP DRAWINGS PRIOR TO PURCHASE.
3. CONNECTION TO UNIT IN SEALTIGHT.
4. PROVIDE A LOCAL DISCONNECT AT UNIT LOCATION IF PANELBOARD IS NOT IN VIEW AND FURTHER THAN 50' FROM UNIT. DISCONNECT TO BE NEMA 3R FOR EXTERIOR LOCATIONS OR IN MECHANICAL ROOM. PROVIDE NEMA 1 FOR INTERIOR APPLICATIONS.
5. PROVIDE A LOCAL FUSIBLE DISCONNECT AT UNIT LOCATION IF PANELBOARD IS NOT IN VIEW AND FURTHER THAN 50' FROM UNIT. DISCONNECT TO BE NEMA 3R FOR EXTERIOR LOCATIONS OR IN MECHANICAL ROOM. PROVIDE NEMA 1 FOR INTERIOR APPLICATIONS.
6. ALTERNATE SCOPE OF WORK. PROVIDE ADD ALTERNATE PRICING TO INCLUDE THIS SCOPE OF WORK.
7. FEED ELECTRICAL AND CONTROLS FROM OUTDOOR UNIT. REFER TO MANUFACTURER'S INSTALLATION INSTRUCTIONS FOR WIRING REQUIREMENTS BETWEEN EQUIPMENT.

ISSUED FOR
BID

NOT FOR
CONSTRUCTION



200 CHURCH STREET
BURLINGTON, VERMONT

NO.	DATE	REVISION
PROJECT #:	21201	
DRAWN:	ARW	
CHECKED:	GDM	
DATE:	8/17/2022	
SCALE:	AS NOTED	

ELECTRICAL
SCHEDULES, NOTES
& LEGENDS

E5.01

Exhibit C – Contractor’s BID FORM
PROJECT: 200 Church Street HVAC

Contractor: _____

Address: _____

Contact: _____

Telephone/Email: _____

Estimated Start Date: _____

Estimated End Date: _____

ITEM	UNIT	SUBTOTAL
HVAC System Installation as Specified	Lump Sum	\$

TOTAL BID: \$ _____

BY SIGNING THIS BID FORM, THE CONTRACTOR AGREES TO ABIDE BY ALL SPECIFICATIONS AND CONDITIONS IN THE CONTRACT DOCUMENTS.

SIGNATURE & DATE

NAME

TITLE

WITH THIS BID, THE CONTRACTOR MUST INCLUDE SIGNED CERTIFICATES OF COMPLIANCE WITH LIVABLE WAGE (for projects over \$15K), OUTSOURCING AND UNION DETERRENCE. THESE FORMS ARE INCLUDED IN EXHIBITS F, G AND H.

Exhibit D

Exhibit D:
DRAFT BURLINGTON STANDARD CONTRACT CONDITIONS
FOR CONSTRUCTION CONTRACTORS

1. DEFINITIONS:

- A. The “Contract” shall mean the Contract between Contractor and the City to which these conditions apply and includes this Attachment C.
- B. The “Contractor” shall mean _____.
- C. The “City” shall mean the City of Burlington, Vermont or any of its departments.
- D. The “Effective Date” shall mean the date on which the Contract becomes effective according to its terms, or if no effective date is stated, the date that all parties to it have signed.
- E. The “Parties” shall mean the parties to this Contract.
- F. The “Work” shall mean the services being provided by the Contractor, as provided in the Contract.

2. REGISTRATION: The Contractor agrees to be registered with the Vermont Secretary of State’s office as a business entity doing business in the State of Vermont at all times this contract is effective. This registration must be complete prior to contract execution.

3. INSURANCE: Prior to beginning any work, the Contractor shall obtain the following insurance coverage from an insurance company registered and licensed to do business in the State of Vermont and having an A.M. Best insurance rating of at least A-, financial size category VII or greater (www.ambest.com). The certificate of insurance coverage shall be documented on forms acceptable to the City. Compliance with minimum limits and coverage, evidenced by a certificate of insurance showing policies and carriers that are acceptable to the City, must be received prior to the Effective Date of the Contract. The insurance policies shall provide that insurance coverage cannot be canceled or revised without thirty (30) days prior notice to the City. If this Contract extends to more than one year, evidence of continuing coverage must be submitted to the City on an annual basis. Copies of any insurance policies may be required. Each policy (with the exception of professional liability and worker’s compensation) shall name the City as an additional insured for the possible liabilities resulting from the Contractor’s actions or omissions. The liability insurance furnished by the Contractor is primary and non-contributory for all the additional insured.

The Contractor is responsible to verify and confirm in writing to the City that: (i) all subcontractors must comply with the same insurance requirements as the Contractor; (ii) all coverage shall include adequate protection for activities involving hazardous materials; and (iii) all work activities related to the Contract shall meet minimum coverage and limits.

No warranty is made that the coverage and limits listed herein are adequate to cover and protect the interests of the Contractor for the Contractor’s operations. These are solely minimums that have been developed and must be met to protect the interests of the City.

- A. General Liability And Property Damage: With respect to all operations performed by the Contractor, subcontractors, agents or workers, it is the Contractor’s responsibility to ensure

that general liability insurance coverage, on an occurrence form, provides all major divisions of coverage including, but not limited to:

1. Premises Operations
2. Independent Contractors' Protective
3. Products and Completed Operations
4. Personal Injury Liability
5. Medical Expenses

Coverage limits shall not be less than:

- | | |
|----------------------------------|-------------|
| 1. General Aggregate | \$2,000,000 |
| 2. Products-Completed/Operations | \$2,000,000 |
| 3. Personal & Advertising Injury | \$1,000,000 |
| 4. Each Occurrence | \$1,000,000 |
| 5. Damage to Rented Premises | \$ 250,000 |
| 6. Med. Expense (Any one person) | \$ 5,000 |

B. Workers' Compensation: With respect to all operations performed, the Contractor shall carry workers' compensation insurance in accordance with the laws of the State of Vermont and ensure that all subcontractors carry the same workers' compensation insurance for all work performed by them under this contract. Minimum limits for Employer's Liability:

1. Bodily Injury by Accident: \$500,000 each accident
2. Bodily Injury by Disease: \$500,000 policy limit,
\$500,000 each employee

C. Automobile Liability: The Contractor shall carry commercial automobile liability insurance covering all motor vehicles, including owned, non-owned and hired, used in connection with the Contract. Each policy shall provide coverage with a limit not less than: \$1,000,000 - Combined Single Limit for each occurrence.

D. Umbrella Liability:

1. \$1,000,000 Each Event Limit

\$1,000,000 General Aggregate Limit

4. CONFLICT OF INTEREST: The Contractor shall disclose in writing to the City any actual or potential conflicts of interest or any appearance of a conflict of interest by the Contractor, its employees or agents, or its subcontractors, if any.

5. PERSONNEL REQUIREMENTS AND CONDITIONS: A Contractor shall employ only qualified personnel with responsible authority to supervise the work. The City shall have the right to approve or disapprove key personnel assigned to administer activities related to the Contract.

Except with the approval of the City, during the life of the Contract, the Contractor shall not employ:

1. Any City employees who are directly involved with the awarding, administration, monitoring, or performance of the Contract or any project(s) that are the subjects of the Contract.
2. Any City employees so involved within one (1) year of termination of employment with the City.

The Contractor warrants that no company or person has been employed or retained (other than a bona fide employee working solely for the Contractor) to solicit or secure this Contract, and that no company or person has been paid or has a contract with the Contractor to be paid, other than a bona fide employee working solely for the Contractor, any fee, commission, percentage, brokerage fee, gift, or any other consideration, contingent upon or resulting from the award or making of the Contract. For breach or violation of this warranty, the City shall have the right to annul the Contract, without liability to the City, and to regain all costs incurred by the City in the performance of the Contract.

The City reserves the right to require removal of any person employed by a Contractor from work related to the Contract, for misconduct, incompetence, or negligence, in the opinion of the City, in the due and proper performance of Contractor's duties, or who neglects or refuses to comply with the requirements of the Contract.

6. **PERFORMANCE:** Contractor warrants that performance of Work will conform to the requirements of this Contract. Contractor shall use that degree of ordinary care and reasonable diligence that an experienced and qualified provider of similar services would use acting in like circumstances and experience in such matters and in accordance with the standards, practices and procedures established by Contractor for its own business.
7. **RESPONSIBILITY FOR SUPERVISION:** The Contractor shall assume primary responsibility for general supervision of Contractor employees and any subcontractors for all work performed under the Contract and shall be solely responsible for all procedures, methods of analysis, interpretation, conclusions, and contents of work performed under the Contract. The Contractor shall be responsible to the City for all acts or omissions of its subcontractors and any other person performing work under this Contract.
8. **INSPECTION OF WORK:** The City shall, at all times, have access to the Contractor's work for the purposes of inspection, accounting, and auditing, and the Contractor shall provide whatever access is considered necessary to accomplish such inspections. At any time, the Contractor shall permit the City or representative for the City the opportunity to inspect any plans, drawings, estimates, specifications, or other materials prepared or undertaken by the Contractor pursuant to the Contract, as well as any preparatory work, work-in-progress, or completed work at a field site.

Conferences, visits to a site, or an inspection of the work, may be held at the request of any involved party or by representatives of the City.

- 9. UTILITIES & ACCESS:** Whenever a facility or component of a private, public, or cooperatively-owned utility will be affected by any proposed construction, the Contractor will counsel with the City and will enter into any necessary contacts and discussions with the affected owners regarding any requirement necessary for revisions of facilities or existing installations, both above and below ground. Any such installations must be completely and accurately exhibited on any detail sheets or plans. The Contractor shall inform the City, in writing, of any such contacts and the results thereof.

The City shall provide the land and/or construction easements for the land upon which the Work under this Contract is to be done, and will, so far as is convenient, permit the Contractor to use as much of the land as is required for the erection of temporary construction facilities and storage of materials, together with the right of access to same, but beyond this, the Contractor shall provide at the Contractor's cost and expense any additional land required.

10. PROTECTION OF PROPERTY:

- A. In General:** Contractor shall avoid damage, as a result of its operations, to trees, plant life, existing sidewalks, curbs, streets, alleys, pavements, utilities, adjoining property, the work of other contractors, and the property of the City and others. Contractor shall, at its own expense, repair any damage to any property caused by Contractor's operations.
- B. Underpinning and Shoring:** Contractor shall become familiar with the requirements of local and state laws applicable to underpinning, shoring and other work affecting adjoining property, and wherever required by law Contractor shall shore up, brace, underpin, secure and protect as may be necessary all foundations and other parts of existing structures adjacent to, adjoining, and in the vicinity of the site, which may be affected in any way by the excavations or other operations connected with the work to be performed under this Contract.
- C. Damage to Utilities:** Contractor shall be responsible for all damage to any utility equipment or structures caused by its acts or omissions to act, whether negligent or otherwise, and shall leave the utility equipment or structures in as good condition as they were in prior to the commencement of operations under this contract. However, any utility equipment or structures damaged as a result of any act, or omission to act, of the contractor may, at the option of the city department, utility company, or other party owning or operating the utility equipment or structures damaged, be repaired by the city department, utility company, or other party, and in that event, the cost of repairs shall be borne by Contractor.

- 11. PUBLIC RELATIONS:** Throughout the performance of the Contract, the Contractor will endeavor to maintain good relations with the public and any affected property owners. Personnel employed by or representing the Contractor shall conduct themselves with propriety.

The Contractor agrees to inform property owners and/or tenants, in a timely manner, if there is need for entering upon private property as an agent of the City, in accordance with 19 V.S.A. § 35 and §.503, to accomplish the work under the Contract. The Contractor agrees that any work will be done with minimum damage to the property and disturbance to the owner. Upon request of the Contractor, the City shall furnish a letter of introduction to property owners soliciting their cooperation and explaining that the Contractor is acting as an agent of the City.

- 12. ACKNOWLEDGEMENTS:** Acknowledgment of the City's support must be included in any and all publications, renderings and project publicity, including audio/visual materials developed under this contract.

13. APPEARANCES:

- A. Hearings and Conferences: The Contractor shall provide services required by the City and necessary for furtherance of any work covered under the Contract. These services shall include appropriate representation at design conferences, public gatherings and hearings, and appearances before any legislative body, commission, board, or court, to justify, explain and defend its contractual services covered under the Contract.

The Contractor shall perform any liaison that the City deems necessary for the furtherance of the work and participate in conferences with the City, at any reasonable time, concerning interpretation and evaluation of all aspects covered under the Contract.

The Contractor further agrees to participate in meetings with the City and any other interested or affected participant, for the purpose of review or resolution of any conflicts pertaining to the Contract.

The Contractor shall be equitably paid for such services and for any reasonable expenses incurred in relation thereto in accordance with the Contract.

- B. Appearance as Witness: If and when required by the City, the Contractor, or an appropriate representative, shall prepare and appear for any litigation concerning any relevant project or related contract, on behalf of the City. The Contractor shall be equitably paid, to the extent permitted by law, for such services and for any reasonable expenses incurred in relation thereto, in accordance with the Contract.

- 14. RESPONSIBILITY OF COST:** The Contractor shall furnish and pay the cost, including taxes (except tax-exempt entities) and all applicable fees, of all the necessary materials and shall furnish and pay for full time on-site superintendence during any construction activity, labor, tools, equipment, and transportation. The Contractor shall perform all the Work required for the construction of all items listed and itemized under Attachment A (Request for Proposals) and Attachment B (Contractor's Response to Request for Proposals) and in strict accordance with the Contract Documents and any amendments thereto and any approved supplemental plans and specifications. The Contractor agrees to pay all claims for labor, materials, services and supplies and agrees to allow no such charge, including no mechanic's lien, to be fixed on the property of the City.

15. PAYMENT PROCEDURES: The City shall pay or cause to be paid to the Contractor or the Contractor's legal representative payments in accordance with the Contract. When applicable, for the type of payment specified in the Contract, a progress report shall summarize actual costs and any earned portion of fixed fee. All payments will be made in reliance upon the accuracy of all representations made by the Contractor, whether in invoices, progress reports, emails, or other proof of work.

All invoices and correspondence shall indicate the applicable project name, project number and the Contract number. When relevant, the invoice shall further be broken down in detail between projects.

When applicable, for the type of payment specified in the Contract, expenses for meals and travel shall be limited to the current approved in-state rates, as determined by the State of Vermont's labor contract, and need not be receipted. All other expenses are subject to approval by the City and must be accompanied by documentation to substantiate their charges.

No approval given or payment made under the Contract shall be conclusive evidence of the performance of the Contract, either wholly or in part, and no payment shall be construed to be acceptance of defective work or improper materials.

The City agrees to pay the Contractor and the Contractor agrees to accept as full compensation, for performance of all services rendered and expenses encompassed in conformance therewith, the fee specified in the Contract.

16. DUTY TO INFORM CITY OF CONTRACT DOCUMENT ERRORS: If Contractor knows, or has reasonable cause to believe, that a clearly identifiable error or omission exists in the Contract Documents, including but not limited to unit prices and rate calculations, Contractor shall immediately give the City written notice thereof. Contractor shall not cause or permit any Work to be conducted which may relate to the error or omission without first receiving written notice by the City that City representatives understand the possible error or omission and have approved of modifications to the Contract Documents or that Contractor may proceed without any modification being made to Contract Documents.

17. NON-APPROPRIATION: The obligations of the City under this Contract are subject to annual appropriation by the Burlington City Council. If no funds or insufficient funds are appropriated or budgeted to support continuation of payments due under this Contract, the Contract shall terminate automatically on the first day of the fiscal year for which funds have not been appropriated. The Parties understand and agree that the obligations of the City to make payments under this Contract shall constitute a current expense of the City and shall not be construed to be a debt or a pledge of the credit of the City. The decision whether or not to budget and appropriate funds during each fiscal year of the City is within the discretion of the Mayor and City Council of the City. The City shall deliver written notice to Contractor as soon as practicable of any non-appropriation, and Contractor shall not be entitled to any payment or compensation of any kind for work performed after the City has delivered written notice of non-appropriation.

18. CHANGE ORDERS & AMENDMENTS: No changes or amendments to the Contract shall be effective unless documented in writing and signed by authorized representatives of the City and the Contractor. All changes affecting the Project's construction cost, length of time, or modifications of the terms or conditions of the Contract, must be authorized by means of a written Contract Change Order which is mutually agreed to by the City and Contractor. The Contract Change Order will include extra Work, Work for which quantities have been altered from those shown in the Bid Schedule, as well as decreases or increases in the quantities of installed units from those shown in the Bid Schedule because of final measurements. All changes must be recorded on a Contract Change Order (which form is part of these Contract Documents) and fully executed before they can be included in a partial payment estimate. Changes for Work, quantities, and/or conditions will include any respective time adjustment, if justified. Time adjustments will require an updated Project Schedule with the Change Order.

19. EXTENSION OF TIME: The Contractor agrees to prosecute the work continuously and diligently, and no charges or claims for damages shall be made by the Contractor for delays or hindrances, from any cause whatsoever, during the progress of any portion of services specified in the Contract. The Contractor may request an extension of time for such delays or hindrances, if any.

Time extensions may be granted by amendment only for excusable delays, such as delays beyond the control of the Contractor and without the fault or negligence of the Contractor.

The City may suspend the work or any portion thereof for a period of not more than ninety (90) days at its discretion or such further time as agreed by the Contractor. The Contractor will be allowed an extension of contract time directly attributable to any suspension.

20. PUBLIC HEALTH EMERGENCY:

A. Compliance with Mandates and Guidance: The Contractor is advised that public health emergencies—meaning public health emergencies, as declared by the City, the State of Vermont, or the Federal Government—may introduce significant uncertainty into the project. The Contractor must comply with all local, state, federal orders, directives, regulations, guidance, advisories during a public health emergency. Contractor shall adhere to the below provisions and consider public health emergencies as it develops project schedules and advances the Work.

B. Creation of Public Health Emergency Plan: For any work performed on-site at a City location, the Contractor shall create a public health emergency plan acceptable to the City. The Contractor shall be responsible for following this plan and ensuring that the project or site is stable and in a safe and maintainable condition.

- a. **Public Health Emergency Plan:** The Public Health Emergency Plan will contain:
 - i. Measures to manage risk and mitigate potential impacts to the health and safety of the public, the City and Contractor's workers;

- ii. Explicit reference to any health and safety performance standards and mandates provided by the City, the State of Vermont, the Federal government, or other relevant governmental entities;
- iii. A schedule for possible updates to the plan as standards and mandates change; and
- iv. Means to adjust the schedule and sequence of work should the emergency change in nature or duration.

b. Review and Acceptance of Plan:

- i. Contractor must provide the plan to the City by the Effective Date of this Contract or by one (1) week prior to the commencement of on-site activities, whichever is later.
- ii. The City shall have sole discretion to require changes to the plan.
- iii. The City may revisit the plan at any time to verify compliance with obligations that arise under a state of emergency.

C. Enforcement & Stoppage of Work: Contractor fails to comply with either 1) the approved public health emergency plan, or 2) any local, state, federal orders, directives, regulations, guidance, or advisories during a public health emergency, the City may stop Work under the Contract until such failure is corrected. Such failure to comply shall constitute a breach of the Contract.

Upon stoppage of work, the City may allow Work to resume, at a time determined by the City, under this Contract if such failure to comply is adequately corrected. The City shall have sole discretion in determining if Contractor has adequately corrected its failure to comply with the above.

If Contractor's breach of Contract has not been cured within seven (7) days after notice to stop Work from the City, then City may terminate this Contract, at its discretion.

D. City Liability Relating to Potential Delays: If a public health emergency is declared, the City will not be responsible for any delays related to the sequence of operations or any expenses or losses incurred as a result of any delays. Any delays related to a public health emergency will be excusable, but will not be compensable.

21. FORCE MAJEURE: Neither Party to this Contract shall be liable to the other for any failure or delay of performance of any obligation under this Contract to the extent the failure or delay is caused by acts of God, public health emergencies, epidemics, acts of the public enemy, acts of superior governmental authority, weather conditions, riots, rebellion, sabotage, or any other circumstances for which it is not responsible or which is not under its control ("Force Majeure"). To assert Force Majeure, the nonperforming party must prove that a) it made all reasonable efforts to remove, eliminate, or minimize the cause of delay or damage, b) diligently pursued performance of its obligations, c) substantially fulfilled all

obligations that could be fulfilled, and d) timely notified the other part of the likelihood or actual occurrence of a Force Majeure event. If any such causes for delay are of such magnitude as to prevent the complete performance of the Contract within two (2) years of the originally scheduled completion date, either Party may by written notice request to amend or terminate the Contract. The suspension of any obligations under this section shall not cause the term of this Contract to be extended and shall not affect any rights accrued under this Contract prior to the occurrence of the Force Majeure. The Party giving notice of the Force Majeure shall also give notice of its cessation.

22. PAYMENT FOR EXTRA WORK, ADDITIONAL SERVICES OR CHANGES: The City may, in writing, require or agree to changes, or additions to or deletions from the originally contemplated scope of work.

The value of such changes, to the extent not reflected in other payments to the Contractor, shall be incorporated in an amendment and be determined by mutual agreement, by one or more of the following:

1. Fixed Price. By a price that is not subject to any adjustment on the basis of the Contractor's expenses experienced in performing the work. The Contractor is fully responsible for all costs and resulting profit or loss.
2. Rate Schedule. By unit prices designated in the Contract, or by unit prices covered under any subsequent contracts.
3. Actual Cost. By amounts determined on the basis of actual costs incurred, as distinguished from forecasted expenditures.

No changes for which additional fee payment is claimed shall be made unless pursuant to a written order from the City, and no claim for payment shall be valid unless so ordered.

The Contractor agrees to maintain complete and accurate records of all change work, in a form satisfactory to the City. The City reserves the right to audit the records of the Contractor related to any extra work or additional services. Any such services rendered shall be subject, in all other respects, to the terms of the Contract. When changes are so ordered, no additional work shall be performed by the Contractor until a Contract amendment has been fully executed, unless written notice to proceed is issued by the City. Any claim for extension of time that may be necessitated as a result of extra work or additional services and changes shall be given consideration and evaluated insofar as it directly relates to the change.

23. FAILURE TO COMPLY WITH TIME SCHEDULE: If the City is dissatisfied because of slow progress or incompetence in the performance of the Work in accordance with the schedule for completion of the various aspects of construction, the City shall give the Contractor written notice in which the City shall specify in detail the cause of dissatisfaction. Should the Contractor fail or refuse to remedy the matters complained of within five days after the written notice is received by the Contractor, the City shall have the right to take control of the Work and either make good the deficiencies of the Contractor itself or direct the activities of the

Contractor in doing so, employing such additional help as the City deems advisable. In such events, the City shall be entitled to collect from the Contractor any expenses in completing the Work. In addition, the City may withhold from the amount payable to the Contractor an amount approximately equal to any interest lost or charges incurred by the City for each calendar day that the Contractor is in default after the time of completion stipulated in the Contract Documents.

24. RETURN OF MATERIALS: Contractor agrees that at the expiration or termination of this Contract, it shall return to City all materials provided to it during its engagement on behalf of City.

25. ACCEPTANCE OF FINAL PAYMENT; RELEASE: Contractor's acceptance of the final payment shall be a release in full of all claims against the City or its agents arising out of or by reason of the Work. Any payment, however, final or otherwise, shall not release the Contractor or its sureties from any obligations under the Contract Documents or any performance or payment bond.

26. OWNERSHIP OF THE WORK: The Contractor agrees that the ownership of all studies, data sheets, survey notes, subsoil information, drawings, tracings, estimates, specifications, proposals, diagrams, calculations, EDM and other material prepared or collected by the Contractor, hereafter referred to as "instruments of professional service", shall become the property of the City as they are prepared and/or developed in the course of the Contract. The Contractor agrees to allow the City access to all "instruments of professional service" at any time. The Contractor shall not copyright any material originating under the Contract without prior written approval of the City. No publications or publicity of the work, in part or in total, shall be made without the express written agreement of the City, except that Contractor may in general terms use previously developed instruments of professional service to describe its abilities for a project in promotional materials.

27. PROPRIETARY RIGHTS: The Parties under the Contract hereby mutually agree that, if patentable discoveries or inventions should result from work performed by the Contractor under the Contract, all rights accruing from such discoveries or inventions shall be the sole property of the Contractor. The Contractor, however, agrees to and does hereby grant to the City an irrevocable, nonexclusive, non-transferable, and royalty-free license to the manufacture, use, and disposition of any discovery or invention that may be developed as a part of the Work under the Contract.

28. PUBLIC RECORDS: The Contractor understands that any and all records related to and acquired by the City, whether electronic, paper, or otherwise recorded, are subject to the Vermont Public Records Act and that the determination of how those records must be handled is solely within the purview of City. The Contractor shall identify all records that it considers to be trade secrets as that term is defined by subsection 317(c)(9) of the Vermont Public Records Act and shall also identify all other records it considers to be exempt under the Act. It is not sufficient to merely state generally that the record is proprietary or a trade secret or is otherwise exempt. Particular records, pages or section which are believed to be exempt must be specifically identified as such and must be separated from other records with a convincing

explanation and rationale sufficient to justify each exemption from release consistent with Section 317 of Title 1 of the Vermont Statutes Annotated.

29. RECORDS RETENTION AND ACCESS: The Contractor agrees to retain, in its files, and to produce to the City—within the time periods requested—all books, documents, electronic data media (EDM), accounting records, and other records produced or acquired by the Contractor in the performance of this Contract which are related to the City, at any time during this Contract and for a period of at least three (3) years after its completion or termination. In addition, if any audit, claim, or litigation is commenced before the expiration of that three (3) year period, the records shall be retained until all related audits, claims, or litigation are resolved. The Contractor further agrees that the City shall have access to all the above information for the purpose of review and audit during the Contract period and any time within the aforementioned retention period. Copies of all of the above referenced information shall be provided to the City, if requested, in the format in which the records were obtained, created, or maintained, such that their original use and purpose can be achieved. Contractor, subcontractors, or their representatives performing work related to the Contract, are responsible to ensure that all data and information created or stored on EDM is secure and can be duplicated and used if the EDM mechanism is subjected to power outage, obsolescence, or damage.

30. WARRANTY: In addition to any warranty provided by the manufacturer or distributor, Contractor guarantees the Work performed, and all materials or equipment furnished, to be free from defects in material and workmanship for a minimum period of one (1) year from the date of the City's acceptance of completion. The Contractor's warranty is not intended and shall not be interpreted as a limitation upon the City's rights or a waiver of manufacturer and distributor warranties, any subcontractor warranties, or any other warranties provided in connection with the Work.

Contractor, at its own expense, shall make any repairs, or replacement necessary to correct these defects to the satisfaction of the City.

This warranty of material and workmanship applies only:

1. To the property only as long as it remains in the possession of the City.
2. To the Work that has not been subject to accident, misuse, or abuse by someone other than the Contractor.
3. To the Work that has not been modified, altered, defaced, or had repairs made or attempted by someone other than the Contractor.
4. If the Contractor is immediately notified in writing within ten (10) days of first knowledge of the defect by the City.
5. If the Contractor is given the first opportunity to make any repairs, replacements, or corrections to the defective construction at no cost to the City within a reasonable period of time.

Under no circumstances shall Contractor be liable by virtue of this warranty or otherwise for damage to any person or property whatsoever for any special, indirect, secondary or consequential damages of any nature however arising out of the use or inability to use because of the construction defect.

If the Contractor is unable, after receipt of two (2) written notices given to Contractor by the City, to successfully repair or replace the labor, equipment, or materials within six (6) months of the second notice, then the District's repair and replace warranty shall be deemed to have failed and the City's rights and remedies shall not be limited by the provisions of this section.

31. CONTRACT DISPUTES: In the event of a dispute between the parties to this Contract, each party will continue to perform its obligations unless the Contract is terminated in accordance with these terms.

32. SETTLEMENTS OF MISUNDERSTANDINGS: To avoid misunderstandings and litigation, it is mutually agreed by all Parties that the [Head of Department] shall act as referee on all questions arising under the terms of the Contract and that the decision of the [Head of Department] in such cases shall be binding upon both Parties.

33. CITY'S OPTION TO TERMINATE: The Contract may be terminated in accordance with the following provisions, which are not exclusive:

A. Termination for Convenience: At any time prior to completion of services specified under the Contract, the City may terminate the Contract for any reason by submitting written notice via certified or registered mail to the Contractor, not less than fifteen (15) days prior to the termination date, of its intention to do so. If the termination is for the City's convenience, payment to the Contractor will be made promptly for the amount of any fees earned to the date of the notice of termination and costs of materials obtained in preparation for Work but not yet installed or delivered, less any payments previously made. However, if a notice of termination is given to a Contractor prior to completion of twenty (20) percent of the estimated services, as set forth in the approved Work Schedule and Progress Report, the Contractor will be reimbursed for that portion of any reasonable and necessary expenses incurred to date of the notice of termination that are in excess of the amount earned under its approved fee to the date of said termination. Such requests for reimbursement shall be supported with factual data and shall be subject to the City's approval. The Contractor shall make no claim for additional compensation against the City by reason of such termination.

B. Termination for Cause:

- i. Breach: Contractor shall be in default if Contractor fails in any manner to fully perform and carry out each and all conditions of this Contract, including, but not limited to, Contractor's failure to begin or to prosecute the Work in a timely manner or to make progress as to endanger performance of this Contract; failure to supply a sufficient number of properly skilled employees or a

sufficient quantity of materials of proper quality; failure to perform the Work unsatisfactorily as determined by the City; failure to neglect or refuse to remove materials; or in the event of a breach of warranty with respect to any materials, workmanship, or performance guaranty. Contractor will not be in default for any excusable delays as provided in Sections 18-20.

The City may give Contractor written notice of such default. If Contractor does not cure such default or provide a plan to cure such default which is acceptable to the City within the time permitted by the City, then the City may terminate this contract for cause.

- ii. Dishonest Conduct: If Contractor engages in any dishonest conduct related to the performance or administration of this Contract then the City may immediately terminate this contract.
- iii. Cover: In the event the City terminates this contract as provided in this section, the City may procure, upon such terms and in such manner as the City may deem appropriate, services similar in scope and level of effort to those so terminated, and Contractor shall be liable to the City for all of its costs and damages, including, but not limited to, any excess costs for such services, interest, or other charges the City incurs to cover.
- iv. Rights and Remedies Not Exclusive: The rights and remedies of the City provided in this section shall not be exclusive and are in addition to any other rights and remedies provided by law or under this Contract.

34. GENERAL COMPLIANCE WITH LAWS: The Contractor and any subcontractor approved under this Contract shall comply with all applicable Federal, State and local laws, including but not limited to the Burlington Livable Wage Ordinance, the Non-Outsourcing Ordinance, and the Union-Deterrence Ordinance and shall provide the required certifications attesting to compliance with these ordinances (see attached ordinances and certifications).

35. SAFETY REQUIREMENTS: The Contractor shall comply with all pertinent provisions of the Occupational Safety and Health Administration (OSHA) and any VOSHA (Vermont OSHA) Safety and Health requirements, including the provision and use of appropriate safety equipment and practices.

The Contractor, and not the City, shall be responsible for the safety, efficiency, and adequacy of Contractor's or its subcontractors' plant, appliances, equipment, vehicles, and methods, and for any damages, which may result from their failure or their improper construction, maintenance or operation.

36. CIVIL RIGHTS AND EQUAL EMPLOYMENT OPPORTUNITY: During performance of the Contract, the Contractor will not discriminate against any employee or applicant for employment because of religious affiliation, race, color, national origin, place of birth,

ancestry, age, sex, sexual orientation, gender identity, marital status, veteran status, disability, HIV positive status, crime victim status, or genetic information. Contractor, and any subcontractors, shall comply with any Federal, State, or local law, statute, regulation, executive order, or rule that applies to it or the services to be provided under this contract concerning equal employment, fair employment practices, affirmative action, or prohibitions on discrimination or harassment in employment.

37. CHILD SUPPORT PAYMENTS: By signing the Contract, the Contractor certifies, as of the date of signing the Contract, that the Contractor (a) is not under an obligation to pay child support; or (b) is under such an obligation and is in good standing with respect to that obligation; or (c) has agreed to a payment plan with the Vermont Office of Child Support Services and is in full compliance with that plan. If the Contractor is a sole proprietorship, the Contractor's statement applies only to the proprietor. If the Contractor is a partnership, the Contractor's statement applies to all general partners with a permanent residence in Vermont. If the Contractor is a corporation, this provision does not apply.

38. TAX REQUIREMENTS: By signing the Contract, the Contractor certifies, as required by law under 32 VSA, Section 3113, that under the pains and penalties of perjury, the Contractor is in good standing with respect to payment, or in full compliance with a plan to pay, any and all taxes due the State of Vermont as of the date of signature on the Contract.

39. INDEMNIFICATION:

- A. Indemnification by Contractor: Except for the gross negligence or willful misconduct by the City, or any of its boards, officers, agents, employees, assigns and successors in interest, contractor undertakes and agrees to defend, indemnify and hold harmless the City and any of its boards, officers, agents, employees, assigns, and Successors in Interest from and against all suits and causes of action, claims, losses, demands and expenses, including, but not limited to, attorney's fees (both in house and outside counsel) and cost of litigation (including all actual litigation costs incurred by the City, including but not limited to, costs of experts and consultants), damages or liability of any nature whatsoever, for death or injury to any person, including Contractor's employees and agents, or damage or destruction of any property of either party hereto or of third parties, arising in any manner by reason of the negligent acts, errors, omissions or willful misconduct incident to the performance of this Contract by Contractor or its subcontractors of any tier.
- B. Notice of Claims & City's Right to Participate: If the City, its officers, agents, or employees are notified of any claims asserted against it to which this indemnification provision may apply, the City shall immediately thereafter notify the Contractor in writing that a claim to which the indemnification provision may apply has been filed. Contractor shall immediately retain counsel and otherwise provide a complete defense against the entire claim or suit. The City retains the right to participate, at its own expense, in the defense of any claim, and to approve all proposed settlements of claims to which this provision applies.

C. City's Rights and Remedies: Rights and remedies available to the City under this provision are cumulative of those provided for elsewhere in this Contract and those allowed under the laws of the United States and the State of Vermont.

D. No Indemnification by City: Under no conditions shall the City be obligated to indemnify the Contractor or any third party, nor shall the City be otherwise liable for expenses or reimbursement including attorney's fees, collection costs, or other costs of the Contractor or any third party.

40. NO GIFTS OR GRATUITIES: The Contractor shall not make any payment or gift or donation of substantial value to any elected official, officer, employee, or agent of the City during the term of this Contract.

41. ASSIGNMENT: Contractor shall not sublet or assign this Work, or any part of it, without the written consent of the City. If any subcontractor is approved, Contractor shall be responsible and liable for all acts or omissions of that subcontractor for any Work performed. If any subcontractor is approved, Contractor shall be responsible to ensure that the subcontractor is paid as agreed and that no lien is placed on any City property.

42. TRANSFERS, SUBLETTING, ASSIGNMENTS, ETC: Contractor shall not assign, sublet, or transfer any interest in the work, covered by this Contract, without prior written consent of the City and further, if any subcontractor participates in any work involving additional services, the estimated extent and cost of the contemplated work must receive prior written consent of the City. The approval or consent to assign or sublet any portion of the work, shall in no way relieve the Contractor of responsibility for the performance of that portion of the work so transferred. The form of the subcontractor's contract shall be as developed by the Contractor and approved by the City. The Contractor shall ensure that insurance coverage exists for any operations to be performed by any subcontractor as specified in the insurance requirements section of this Contract.

The services of the Contractor, to be performed under the Contract, shall not be transferred without written authorization of the City. Any authorized sub-contracts shall contain all of the same provisions contained in and attached to the original Contract with the City.

43. CONTINUING OBLIGATIONS: The Contractor agrees that if because of death, disability, or other occurrences, it becomes impossible to effectively perform its services in compliance with the Contract, neither the Contractor nor its surviving members shall be relieved of their obligations to complete the Contract unless the City agrees to terminate the Contract because it determines that the Contractor is unable to satisfactorily execute the Contract.

44. INTERPRETATION & IMPLEMENTATION: Provisions of the Contract shall be interpreted and implemented in a manner consistent with each other and using procedures that will achieve the intent of both Parties.

45. ARM'S LENGTH: This Contract has been negotiated at arm's length, and any ambiguity in any of its terms or provisions shall be interpreted in accordance with the intent of the Parties and not against or in favor of either the City or Contractor.

46. RELATIONSHIP: The Contractor is an independent contractor and shall act in an independent capacity and not as officers or employees of the City. To that end, the Contractor shall determine the method, details, and means of performing the work, but will comply with all legal requirements in doing so. The Contractor shall provide its own tools, materials, or equipment. The Parties agree that neither the Contractor nor its principal(s) or employees are entitled to any employee benefits from the City. Contractor understands and agrees that it and its principal(s) or employees have no right to claim any benefits under the Burlington Employee Retirement System, the City's worker's compensation benefits, health insurance, dental insurance, life insurance, or any other employee benefit plan offered by the City. The Contractor agrees to execute any certifications or other documents and provide any certificates of insurance required by the City and understands that this Contract is conditioned on its doing so, if requested.

The Contractor understands and agrees that it is responsible for the payment of all taxes on the above sums and that the City will not withhold or pay for Social Security, Medicare, or other taxes or benefits or be responsible for any unemployment benefits.

47. CHOICE OF LAW: Vermont law, and rules and regulations issued pursuant thereto, shall be applied in the interpretation, execution, and enforcement of this Contract. Any provision included or incorporated herein by reference which conflicts with said laws, rules, and regulations shall be null and void. Any provision rendered null and void by operation of this provision shall not invalidate the remainder of this Contract to the extent capable of execution.

48. JURISDICTION: All suits or actions related to this Contract shall be filed and proceedings held in the State of Vermont.

49. BINDING EFFECT AND CONTINUITY: This Contract shall be binding upon and shall inure to the benefit of the Parties, their respective heirs, successors, representatives, and assigns. If a dispute arises between the Parties, each Party will continue to perform its obligations under this Contract during the resolution of the dispute, until the Contract is terminated in accordance with its terms.

50. SEVERABILITY: The invalidity or unenforceability of any provision of this Contract or the Contract Documents shall not affect the validity or enforceability of any other provision, which shall remain in full force and effect, provided that the Parties can continue to perform their obligations under this Contract in accordance with the intent of this Contract.

51. ENTIRE CONTRACT & AGREEMENT: This Contract, including the Contract Documents, constitutes the entire Contract, agreement, and understanding of the Parties with respect to the subject matter of this Contract. Prior or contemporaneous additions, deletions, or other changes to this Contract shall not have any force or effect whatsoever, unless embodied herein.

52. APPENDICES: The City may attach, to these specifications, appendices containing various forms and typical sample sheets for guidance and assistance to the Contractor in the performance of the work. It is understood, however, that such forms and samples may be modified, altered, and augmented from time to time by the City as occasions may require. It is the responsibility of the Contractor to ensure that they have the latest versions applicable to the Contract.

53. NO THIRD PARTY BENEFICIARIES: This Contract does not and is not intended to confer any rights or remedies upon any person or entity other than the Parties. Enforcement of this Contract and all rights and obligations hereunder are reserved solely to the Parties. Any services or benefits which third parties receive as a result of this Contract are incidental to this Contract, and do not create any rights for such third parties.

54. WAIVER: A Party's failure or delay in exercising any right, power, or privilege under this Contract, whether explicit or by lack of enforcement, shall not operate as a waiver, nor shall any single or partial exercise of any right, power, or privilege preclude any other or further exercise of such right, power, or privilege.

Exhibit F

Rights & Responsibilities

Under Burlington's Livable Wage Ordinance

\$16.98/hr

WHEN

employer *provides* employer assisted health insurance

\$18.09/hr

WHEN

employer *does not provide* employer assisted health insurance

and 12 days of paid time off per year*

*prorated for part-time employees

The law requires employers to display this poster where employees can readily see it.

COVERAGE

Any employer who receives City contracts or grants totaling in excess of \$15,000 for any 12-month period is covered. Covered employees are entitled to livable wages, 12 days paid time off per year* for vacation, sick leave, or personal leave, and all rights under the Fair Labor Standards Act (FLSA), as well as other applicable state and federal laws.

Covered contractors are required to include all subcontracts notice of the Livable Wage Ordinance (LWO), and are liable for LWO violations committed by their covered subcontractors.

ENFORCEMENT

The City is responsible for the administration of the LWO, and has the authority to recover back wages in instances of violations. Employers found in violation of the LWO may be assessed monetary penalties and be barred from future City contracts and grants. The law prohibits retaliation against workers who file a complaint or participate in any proceeding under the LWO.

ADDITIONAL INFORMATION

To obtain additional information about your rights and responsibilities under the LWO, visit the LWO Landing Page (<https://www.burlingtonvt.gov/CT/Livable-Wage-Ordinance>) or contact the LWO at their email address (livablewage@burlingtonvt.gov).

Livable Wage July 1, 2022 - June 30, 2023

Effective July 1, 2022

ARTICLE VI. LIVABLE WAGES¹

21-80 Findings and purpose.

In enacting this article, the city council states the following findings and purposes:

- (a) Income from full-time work should be sufficient to meet an individual's basic needs;
- (b) The City of Burlington is committed to ensuring that its employees have an opportunity for a decent quality of life and are compensated such that they are not dependent on public assistance to meet their basic needs;
- (c) The City of Burlington is committed, through its contracts with vendors and provision of financial assistance, to encourage the private sector to pay its employees a livable wage and contribute to employee health care benefits;
- (d) The creation of jobs that pay livable wages promotes the prosperity and general welfare of the City of Burlington and its residents, increases consumer spending with local businesses, improves the economic welfare and security of affected employees and reduces expenditures for public assistance;
- (e) It is the intention of the city council in passing this article to provide a minimum level of compensation for employees of the City of Burlington and employees of entities that enter into service contracts or receive financial assistance from the City of Burlington.

(Ord. of 11-19-01; Ord. of 10-21-13)

21-81 Definitions.

As used in this article, the following terms shall be defined as follows:

- (a) *Contractor or vendor* is a person or entity that has a service contract with the City of Burlington where the total amount of the service contract or service contracts exceeds fifteen thousand dollars (\$15,000.00) for any twelve (12) month period, including any subcontractors of such contractor or vendor.
- (b) *Grantee* is a person or entity that is the recipient of financial assistance from the City of Burlington in the form of grants, including any contractors or subgrantees of the grantee, that exceed fifteen thousand dollars (\$15,000.00) for any twelve (12) month period.

(c) *Covered employer* means the City of Burlington, a contractor or vendor or a grantee as defined above. The primary contractor, vendor, or grantee shall be responsible for the compliance of each of its subcontractors (or of each subgrantee) that is a covered employer.

(d) *Covered employee* means an "employee" as defined below, who is employed by a "covered employer," subject to the following:

(1) An employee who is employed by a contractor or vendor is a "covered employee" during the period of time he or she expends on furnishing services under a service contract with the City of Burlington, notwithstanding that the employee may be a temporary or seasonal employee;

(2) An employee who is employed by a grantee who expends at least half of his or her time on activities funded by the City of Burlington is a "covered employee."

(e) *Designated accountability monitor* shall mean a nonprofit corporation which has established and maintains valid nonprofit status under Section [501\(c\)\(3\)](#) of the United States Internal Revenue Code of 1986, as amended, and that is independent of the parties it is monitoring.

(f) *Employee* means a person who is employed on a full-time or part-time regular basis. In addition, commencing with the next fiscal year, a seasonal or temporary employee of the City of Burlington who works ten (10) or more hours per week and has been employed by the City of Burlington for a period of four (4) years shall be considered a covered employee commencing in the fifth year of employment. "Employee" shall not refer to volunteers working without pay or for a nominal stipend, persons working in an approved apprenticeship program, persons who are hired for a prescribed period of six (6) months or less to fulfill the requirements to obtain a professional license as an attorney, persons who are hired through youth employment programs or student workers or interns participating in established educational internship programs.

(g) *Employer-assisted health care* means health care benefits provided by employers for employees (or employees and their dependents) at the employer's cost or at an employer contribution towards the purchase of such health care benefits, provided that the employer cost or contribution consists of at least one dollar and twenty cents (\$1.20) per hour. (Said amount shall be adjusted every two (2) years for inflation, by the chief administrative officer of the city.)

(h) *Livable wage* has the meaning set forth in Section [21-82](#).

(i) *Retaliation* shall mean the denial of any right guaranteed under this article, and any threat, discipline, discharge, demotion, suspension, reduction of hours, or any other adverse action against an employee for exercising any right guaranteed under this article. Retaliation shall also include coercion, intimidation, threat, harassment, or interference in any manner with any investigation, proceeding, or hearing under this article.

(j) *Service contract* means a contract primarily for the furnishing of services to the City of Burlington (as opposed to the purchasing or leasing of goods or property). A contract involving the furnishing of financial products, insurance products, or software, even if that contract also includes some support or other services related to the provision of the products, shall not be considered a service contract.

(Ord. of 11-19-01; Ord. of 10-21-13)

21-82 Livable wages required.

(a) Every covered employer shall pay each and every covered employee at least a livable wage no less than:

(1) For a covered employer that provides employer-assisted health care, the livable wage shall be at least fifteen dollars and thirty-five cents (\$15.35) per hour on the effective date of the amendments to this article.

(2) For a covered employer that does not provide employer-assisted health care, the livable wage shall be at least sixteen dollars and seventy-four cents (\$16.74) per hour on the effective date of the amendments to this article.

(3) Covered employees whose wage compensation consists of more or other than hourly wages, including, but not limited to, tips, commissions, flat fees or bonuses, shall be paid so that the total of all wage compensation will at least equal the livable wage as established under this article.

(b) The amount of the livable wage established in this section shall be adjusted by the chief administrative officer of the city as of July 1 of each year based upon a report of the Joint Fiscal Office of the State of Vermont that describes the basic needs budget for a single person but utilizes a model of two (2) adults residing in a two (2) bedroom living unit in an urban area with the moderate cost food plan. Should there be no such report from the Joint Fiscal Office, the chief administrative officer shall obtain and utilize a basic needs budget that applies a similar methodology. The livable wage rates derived from utilizing a model of two (2) adults residing in a two (2) bedroom living unit in an urban area with a moderate cost food plan shall not become effective until rates meet or exceed the 2010 posted livable wage rates. Prior to May 1 preceding any such adjustment and prior to

May 1 of each calendar year thereafter, the chief administrative officer will provide public notice of this adjustment by posting a written notice in a prominent place in City Hall by sending written notice to the city council and, in the case of covered employers that have requested individual notice and provided contact information to the chief administrative officer, by notice to each such covered employer. However, once a livable wage is applied to an individual employee, no reduction in that employee's pay rate is permissible due to this annual adjustment.

(c) Covered employers shall provide at least twelve (12) compensated days off per year for full-time covered employees, and a proportionate amount for part-time covered employees, for sick leave, vacation, personal, or combined time off leave.

(Ord. of 11-19-01; Ord. of 5-2-11; Ord. of 6-13-11; Ord. of 10-21-13)

21-83 Applicability.

(a) This article shall apply to any service contract or grant, as provided by this article that is awarded or entered into after the effective date of the article. After the effective date of the article, entering into any agreement or an extension, renewal or amendment of any contract or grant as defined herein shall be subject to compliance with this article.

(b) The requirements of this article shall apply during the term of any service contract subject to the article. Covered employers who receive grants shall comply with this article during the period of time the funds awarded by the City of Burlington are being expended by the covered employer.

(Ord. of 11-19-01; Ord. of 10-21-13)

21-84 Enforcement.

(a) Each service contract or grant covered by this article shall contain provisions requiring that the covered employer or grantee submit a written certification, under oath, during each year during the term of the service contract or grant, that the covered employer or grantee (including all of its subcontractors and subgrantees, if any) is in compliance with this article. The failure of a contract to contain such provisions does not excuse a covered employer from its obligations under this article. The covered employer shall agree to post a notice regarding the applicability of this section in any workplace or other location where employees or other persons contracted for employment are working. The covered employer shall agree to provide payroll records or other documentation for itself and any subcontractors or subgrantees, as deemed necessary by the chief

administrative officer of the City of Burlington, within ten (10) business days from receipt of the City of Burlington's request.

(b) The chief administrative officer of the City of Burlington may require that a covered employer submit proof of compliance with this article at any time, including but not limited to:

- (1) Verification of an individual employee's compensation;
- (2) Production of payroll, health insurance enrollment records, or other relevant documentation; or
- (3) Evidence of proper posting of notice.

If a covered employer is not able to provide that information within ten (10) business days of the request, the chief administrative officer may turn the matter over to the city attorney's office for further enforcement proceedings.

(c) The City of Burlington shall appoint a designated accountability monitor that shall have the authority:

- (1) To inform and educate employees of all applicable provisions of this article and other applicable laws, codes, and regulations;
- (2) To create a telephonic and electronic accountability system under this article that shall be available at all times to receive complaints under this article;
- (3) To establish and implement a system for processing employees' complaints under this article, including a system for investigating complaints and determining their initial credibility; and
- (4) To refer credible complaints to the city attorney's office for potential enforcement action under this article.

The designated accountability monitor shall forward to the City of Burlington all credible complaints of violations within ten (10) days of their receipt.

(d) Any covered employee who believes his or her covered employer is not complying with this article may file a complaint in writing with the city attorney's office within one (1) year after the alleged violation. The city attorney's office shall conduct an investigation of the complaint, during which it may require from the covered employer evidence such as may be required to determine whether the covered employer has been compliant, and shall make a finding of compliance or noncompliance within a reasonable time after receiving the

complaint. Prior to ordering any penalty provided in subsection (e), (f), or (g) of this section, the city attorney's office shall give notice to the covered employer. The covered employer may request a hearing within thirty (30) days of receipt of such notice. The hearing shall be conducted by a hearing officer appointed by the city attorney's office, who shall affirm or reverse the finding or the penalty based upon evidence presented by the city attorney's office and the covered employer.

(e) The City of Burlington shall have the right to modify, terminate and/or seek specific performance of any contract or grant with a covered employer from any court of competent jurisdiction, if the covered employer has not complied with this article.

(f) Any covered employer who violates this article may be barred from receiving a contract or grant from the city for a period up to two (2) years from the date of the finding of violation.

(g) A violation of this article shall be a civil offense subject to a civil penalty of from two hundred dollars (\$200.00) to five hundred dollars (\$500.00). All law enforcement officers and any other duly authorized municipal officials are authorized to issue a municipal complaint for a violation of this article. Each day any covered employee is not compensated as required by this article shall constitute a separate violation.

(h) If a complaint is received that implicates any City of Burlington employee in a possible violation of this article, that complaint will be handled through the City's personnel procedures, not through the process outlined in this article.

(i) Any covered employee aggrieved by a violation of this article may bring a civil action in a court of competent jurisdiction against the covered employer within two (2) years after discovery of the alleged violation. The court may award any covered employee who files suit pursuant to this section, as to the relevant period of time, the following:

(1) The difference between the livable wage required under this article and the amount actually paid to the covered employee;

(2) Equitable payment for any compensated days off that were unlawfully denied or were not properly compensated;

(3) Liquidated damages in an amount equal to the amount of back wages and/or compensated days off unlawfully withheld or fifty dollars (\$50.00) for each employee or person whose rights under this article were violated for each day that the violation occurred or continued, whichever is greater;

(4) Reinstatement in employment and/or injunctive relief; and

(5) Reasonable attorneys' fees and costs.

(j) It shall be unlawful for an employer or any other person to interfere with, restrain, or deny the exercise of, or the attempt to exercise, any right protected under this article. No person shall engage in retaliation against an employee or threaten to do so because such employee has exercised rights or is planning to exercise rights protected under this article or has cooperated in any investigation conducted pursuant to this article.

(Ord. of 11-19-01; Ord. of 2-17-04; Ord. of 5-2-11; Ord. of 10-21-13)

21-85 Other provisions.

(a) No covered employer shall reduce the compensation, wages, fringe benefits or leave available to any covered employee in order to pay the livable wage required by this article. Any action in violation of this subsection shall be deemed a violation of this article subject to the remedies of Section [21-84](#).

(b) No covered employer with a current contract, as of the effective date of this provision, with the City of Burlington for the use of property located at the Burlington International Airport may reduce, during the term of that contract, the wages of a covered employee below the livable wage as a result of amendments to this article.

(c) Where pursuant to a contract for services with the city, the contractor or subcontractor incurs a contractual obligation to pay its employees certain wage rates, in no case except as stated in subsection (d) of this section, shall the wage rates paid pursuant to that contract be less than the minimum livable wage paid pursuant to this article.

(d) Notwithstanding subsection (c) of this section, where employees are represented by a bargaining unit or labor union pursuant to rights conferred by state or federal law and a collective bargaining labor agreement is in effect governing the terms and conditions of employment of those employees, this chapter shall not apply to those employees, and the collective bargaining labor agreement shall control.

(e) Covered employers shall inform employees making less than twelve dollars (\$12.00) per hour of their possible right to the Earned Income Tax Credit under federal and state law.

(f) The chief administrative officer of the city shall have the authority to promulgate rules as necessary to administer the provisions of this article, which shall become effective upon approval by the city council.

(Ord. of 11-19-01; Ord. of 10-21-13)

21-86 Exemptions.

An exemption from any requirement of this article may be requested for a period not to exceed two (2) years:

- (a) By a covered employer where payment of the livable wage would cause substantial economic hardship;
and
- (b) By the City of Burlington where application of this article to a particular contract or grant is found to violate specific state or federal statutory, regulatory or constitutional provisions or where granting the exemption would be in the best interests of the City.

A covered employer or grantee granted an exemption under this section may reapply for an exemption upon the expiration of the exemption. Requests for exemption may be granted by majority vote of the city council. All requests for exemption shall be submitted to the chief administrative officer. The finance committee of the City of Burlington shall first consider such request and make a recommendation to the city council. The decision of the city council shall be final.

(Ord. of 11-19-01; Ord. of 10-21-13)

21-87 Severability.

If any part or parts or application of any part of this article is held invalid, such holding shall not affect the validity of the remaining parts of this article.

(Ord. of 11-19-01; Ord. of 10-21-13)

21-88 Annual reporting.

On or before April 15 of each year, the city attorney's office shall submit a report to the city council that provides the following information:

- (a) A list of all covered employers broken down by department;
- (b) A list of all covered employers whose service contract did not contain the language required by this article;
and
- (c) All complaints filed and investigated by the city attorney's office and the results of such investigation.

(Ord. of 10-21-13)

21-89 Effective date.

The amendments to this article shall take effect on January 1, 2014, and shall not be retroactively applied.

(Ord. of 10-21-13)

Certification of Compliance with the City of Burlington's Livable Wage Ordinance

I, _____, on behalf of _____ ("the Contractor") in connection with a contract for _____ services that we provide to the City, hereby certify under oath that the Contractor (and any subcontractors under this contract) is and will remain in compliance with the City of Burlington's Livable Wage Ordinance, B.C.O. 21-80 et seq., and that

(1) as a condition of entering into this contract or grant, we confirm that all covered employees as defined by Burlington's Livable Wage Ordinance (including the covered employees of subcontractors) shall be paid a livable wage (as determined, or adjusted, annually by the City of Burlington's chief administrative officer) and provided appropriate time off for the term of the contract;

(2) a notice regarding the applicability of the Livable Wage Ordinance shall be posted in the workplace(s) or other location(s) where covered employees work;

(3) we will provide verification of an employee's compensation, produce payroll or health insurance enrollment records or provide other relevant documentation (including that of any subcontractor), as deemed necessary by the chief administrative officer, within ten (10) business days from receipt of a request by the City;

(4) we will cooperate in any investigation conducted by the City of Burlington's City Attorney's office pursuant to this ordinance; and

(5) we will not retaliate (nor allow any subcontractor to retaliate) against an employee or other person because an employee has exercised rights or the person has cooperated in an investigation conducted pursuant to this ordinance.

Date _____ By: Contractor _____

Subscribed and sworn to before me:

Date _____ Notary _____

Exhibit G

ARTICLE VII. OUTSOURCING

21-90 Policy.

It is the policy of the City of Burlington to let service contracts to contractors, subcontractors and vendors who perform work in the United States.

(Ord. of 11-21-05/12-21-05)

21-91 Definitions.

(a) *Contractor or vendor.* A person or entity that has a contract with the City of Burlington primarily for the furnishing of services (as opposed to the purchasing of goods), including any subcontractors of such contractor or vendor.

(b) *Government funded project.* Any contract for services which involves any city funds and the total amount of the contract is fifty thousand dollars (\$50,000.00) or more. Burlington School Department contracts shall not be considered government funded projects under this article.

(c) *Outsourcing.* The assigning or reassigning, directly, or indirectly through subcontracting, of services under a government funded project to workers performing the work outside of the United States.

(Ord. of 11-21-05/12-21-05)

21-92 Implementation.

(a) No contract for a government funded project shall be let to any contractor, subcontractor, or vendor who is outsourcing, or causing the work to be performed outside of the United States or Canada.

(b) Prior to the commencement of work on a government funded project a contractor, subcontractor or vendor shall provide written certification that the services provided under the contract will be performed in the United States or Canada.

(Ord. of 11-21-05/12-21-05)

21-93 Exemption.

An exemption from requirements of this article may be authorized by the chief administrative officer based upon a determination that the services to be performed for the government funded project are not available in the United States or Canada at a reasonable cost. Any such exemption decision by the chief administrative officer

shall be reported to the board of finance in writing within five (5) days. The board of finance may, if it should vote to do so, override the exemption decision if such vote occurs within fourteen (14) days of the date of the chief administrative officer's communication to such board.

(Ord. of 11-21-05/12-21-05)

21-94 Enforcement.

(a) Any contractor, subcontractor or vendor who files false or materially misleading information in connection with an application, certification or request for information pursuant to the provisions of this article or outsources work on a government funded project shall be deemed to be in violation of this article.

(b) A violation of this article shall be a civil offense subject to a civil penalty of from one hundred dollars (\$100.00) to five hundred (\$500.00). All law enforcement officers and any other duly authorized municipal officials are authorized to issue a municipal complaint for a violation of this article. Each day any violation of any provision of this article shall continue shall constitute a separate violation.

(c) The City of Burlington shall have the right to modify, terminate and or seek specific performance of any contract for a government funded project if the contractor, subcontractor or vendor has not complied with this article.

(Ord. of 11-21-05/12-21-05)

21-95—21-99 Reserved.

Certification of Compliance with the City of Burlington's Outsourcing Ordinance

I, _____, on behalf of

_____ (Contractor) and in connection with the

_____ [project], hereby certify under oath that (1) Contractor shall comply with the City of
Burlington's Outsourcing Ordinance (Ordinance §§ 21-90 – 21-93); (2) as a condition of entering
into this contract or grant, Contractor confirms that the services provided under the above-
referenced contract will be performed in the United States or Canada.

Dated at _____, Vermont this ____ day of _____, 20__.

By: _____
Duly Authorized Agent

Subscribed and sworn to before me: _____
Notary

Exhibit H

ARTICLE VIII. UNION DETERRENCE

21-100 Policy.

It is the policy of the City of Burlington to limit letting contracts to organizations that provide union deterrence services to other companies.

(Ord. of 3-27-06/4-26-06)

21-101 Definitions.

(a) *Contractor or vendor.* A person or entity that has a contract with the City of Burlington primarily for the furnishing of services (as opposed to the purchasing of goods), including any subcontractors of such contractor or vendor.

(b) *Government funded project.* Any contract for services which involves any City funds and the total amount of the contract is fifteen thousand dollars (\$15,000.00) or more. Burlington School Department contracts shall not be considered government funded projects under this article.

(c) *Union deterrence services.* Services provided by a contractor, subcontractor or vendor that are not restricted to advice concerning what activities by an employer are prohibited and permitted by applicable laws and regulations, but extend beyond such legal advice to encouraging an employer to do any of the following:

- 1) Hold captive audience, (i.e., mandatory) meetings with employees encouraging employees to vote against the union;
- 2) Have supervisors force workers to meet individually with them to discuss the union;
- 3) Imply to employees, whether through written or oral communication, that their employer may have to shut down or lay people off if the union wins the election;
- 4) Discipline or fire workers for union activity;
- 5) Train managers on how to dissuade employees from supporting the union.

(d) *Substantial portion of income.* For the purposes of this article, substantial portion of income shall mean greater than ten (10) percent of annual gross revenues or one hundred thousand dollars (\$100,000.00), whichever is less.

(Ord. of 3-27-06/4-26-06)

21-102 Implementation.

- (a) No contract for a government funded project shall be let to any contractor, subcontractor, or vendor who
 - 1) Advises or has advised an employer to conduct any illegal activity in its dealings with a union.
 - 2) Advertises union deterrence services as specialty services;
 - 3) Earns a substantial portion of its income by providing union deterrence services to other companies in order to defeat union organizing efforts.
- (b) Prior to the commencement of work on a government funded project a contractor, subcontractor or vendor shall provide written certification that it has not advised the conduct of any illegal activity, it does not currently, nor will it over the life of the contract provide union deterrence services in violation of this article.

(Ord. of 3-27-06/4-26-06)

21-103 Enforcement.

- (a) Any contractor, subcontractor or vendor who files false or materially misleading information in connection with an application, certification or request for information pursuant to the provisions of this article or provided union deterrence services during the life of a contract for a government funded project shall be deemed to be in violation of this article.
- (b) The City of Burlington shall have the right to modify, terminate and or seek specific performance of any contract for a government funded project if the contractor, subcontractor or vendor has not complied with this article.

(Ord. of 3-27-06/4-26-06)

21-104—21-110 Reserved.

Certification of Compliance with the City of Burlington's
Union Deterrence Ordinance

I, _____, on behalf of _____
(Contractor) and in connection with _____ (City
contract/project/grant), hereby certify under oath that _____
(Contractor) has not advised the conduct of any illegal activity, and it does not currently, nor will
it over the life of the contract advertise or provide union deterrence services in violation of the
City's union deterrence ordinance.

Dated at _____, Vermont this ____ day of _____, 20__.

By: _____
Duly Authorized Agent