

Boone County, Kentucky

REQUEST FOR PROPOSAL #08202019SHVAC

HVAC REPLACEMENT FOR THE BOONE COUNTY SHERIFF'S OFFICE

ACCEPTANCE DATE: Tuesday, August 20, 2019 at 2:00pm (Local Time)

MANDATORY PRE-PROPOSAL MEETING/TOUR Tuesday, August 13, 2019 at 1:00 p.m. (Local Time)
Boone County Sheriff's Office
3000 Conrad Lane, Burlington, KY 41005

ACCEPTANCE PLACE Boone County Fiscal Court
2950 Washington Street
PO Box 960
2nd Floor Administration Building, Room 205
Burlington, Kentucky 41005

Requests for information related to this Invitation should be directed to:

Michael Albrecht
E-mail address: malbrecht@boonecountyky.org

Issue Date: July 30th, 2019

ANYONE IN NEED OF ANY REASONABLE ACCOMMODATION FOR ANY TYPE OF DISABILITY IN ORDER TO PARTICIPATE IN THIS PROCUREMENT, SHOULD CONTACT THE HUMAN RESOURCES OFFICE AS SOON AS POSSIBLE

NOTICE

The Boone County Fiscal Court will receive sealed proposals c/o Accounting Manager/ Room #205, Second Floor, Administration Building, 2950 Washington Street, Burlington, Kentucky 41005, until 2:00 p.m., local time, Tuesday, August 20, 2019, from businesses interested in providing **HVAC REPLACEMENT FOR THE BOONE COUNTY SHERIFF'S OFFICE**. The services to Boone County will include disposal and replacement of existing units and all associated automation controls. Proposals will be opened at 2:00 p.m., on the date listed above, in the Fiscal Courtroom, First Floor, of the Administration Building. Late, electronically submitted or facsimile proposals will not be accepted.

PROPOSAL ENVELOPE MUST BE LABELED: "SEALED PROPOSAL: HVAC REPLACEMENT FOR THE BOONE COUNTY SHERIFF'S OFFICE." Envelopes must also be labeled with the name and address of the vendor submitting the proposal.

Any qualified firm or individual interested in offering these services may obtain a copy of the specifications may be obtained in the Finance Office Room #205, 2950 Washington St, Burlington, KY 41005, from the Boone County Kentucky website www.boonecountky.org/publicnotices or by contacting Michael Albrecht at 859-334-3652. A mandatory pre-proposal meeting/tour will be held on Tuesday, August 13th, 2019 at 1:00 p.m. at the Boone County Sheriff's Office located at 3000 Conrad Lane, Burlington, KY 41005.

The hearing and/or speech-impaired may call 1-800-648-6057 and an interpreter will call the County for you.

Boone County reserves the right to reject any and all proposals, to waive any informalities and to negotiate for the modifications of any proposal or to accept that proposal which is deemed the most desirable and advantageous from the standpoint of customer value and service and concept of operations, even though such proposal may not, on its face, appear to be the lowest and best price. No proposal may be withdrawn for a period of thirty (30) days after scheduled time of receipt of proposals.

The Boone County Fiscal Court is an Equal Opportunity Employer. WBE/MBE firms are encouraged to respond to this Request for Proposals.

INTENT

Whenever a specific "Brand Name" is used in these specifications, it is used for descriptive purposes only. The Boone County Property Maintenance Review Committee shall be the sole judge of whether a proposal meets the intent of these specifications.

This is a request for proposals. Any reference to bidder in this document shall be construed as the vendor/firm/contractor submitting the proposal.

KENTUCKY PREFERENCE LAW

The scoring of proposal is subject to Reciprocal preference for Kentucky resident bidders and Preferences for a Qualified Bidder or the Department of Corrections, Division of Prison Industries. *Vendors not claiming resident bidder or qualified bidder status need not submit the corresponding affidavit.

SPECIFICATIONS

1. GENERAL INFORMATION

Boone County, Kentucky, herein referred to as the “County”, is soliciting Request for Proposals (RFP) from qualified firms/contractors that specialize in the replacement/installation of HVAC systems for the Boone County Sheriff’s Office located at 3000 Conrad Lane, Burlington, KY 41005.

2. SPECIFICATIONS

The services desired are set forth in this Request for Proposals. Representatives of the County will review the submitted proposals of each party. The Fiscal Court reserves the right to amend the specifications. Addenda will be available on the County website. Obtaining addenda is the responsibility of the offering party, not the County.

Included as Exhibit A – Sheriff’s Department HVAC Specifications/Common Work Results

Included as Exhibit B – Sheriff’s Department HVAC Drawing Set

3. NOTICE

Pursuant to the provisions of KRS 45A.343, the contractor or vendor is required to reveal to the County any final determination of a violation of KRS Chapters 136, 139, 141, 337, 338 and 342 by the contractor or vendor within the previous five (5) years; and further that said contractor or vendor has been and is in continuous compliance with the provisions of KRS Chapters 136, 139, 141, 337, 341, and 342 for the duration of the contract. The failure of a contractor or vendor to reveal a final determination of a violation to a local government, or to comply with the statutory requirements, is considered grounds for cancellation of a contract and disqualification of the contractor or vendor from eligibility for any County contracts for a period of two (2) years.

The Boone County Fiscal Court reserves the right to reject any and all submissions and to waive formalities.

4. QUALIFICATIONS

All interested parties must possess all federal, state and/or local qualifications/licenses to provide services in Boone County and the Commonwealth of Kentucky.

Insurance - Proposer is required to maintain insurance coverage as follows:

Coverage	Minimum Limits of Liability, Terms and Coverage
Commercial General Liability	\$1,000,000 bodily injury and property damage each occurrence, including advertising and personal injury, products and completed operations
	\$5,000,000 products/completed operations, independent Contractor's liability, contractual liability, and coverage for property damage from perils of explosion, collapse, or damage to underground utilities, commonly known as XCU
	\$5,000,000 general annual aggregate
Auto Liability Insurance	\$1,000,000 each person, bodily injury and property damage, including owned, non-owned and hired auto liability
Workers' Compensation	Statutory Limitations
Employer's Liability	\$1,000,000 bodily injury by accident, each accident
	\$1,000,000 bodily injury by disease, each employee
	\$1,000,000 bodily injury by disease, policy aggregate
Umbrella/Excess Liability	\$5,000,000 each occurrence and annual aggregate
	Underlying coverage shall include General Liability, Auto Liability, and Employer's Liability
	\$1,000,000 annual aggregate covering damages or liability arising or resulting from Contractor's services rendered, or which should have been rendered, pursuant to the Contract
Property	The Contractor shall purchase and maintain property insurance covering machinery, equipment, mobile equipment, and tools used or owned by the Contractor in the performance of services under the Contract. The County shall in no circumstance be responsible or liable for the loss or damage to, or disappearance of, any machinery, equipment, mobile equipment and tools used or owned by the Contractor in the performance of services under the Contract.

Proof of insurance shall be furnished to the County with bid submission. Certificate of insurance naming **Boone County Fiscal Court as additionally insured** shall be furnished within fifteen (15) days of contract execution.

Maintain all current Kentucky HVAC technical licenses.

5. SCOPE OF WORK

Boone County, Kentucky, invites the submittal of written proposals from qualified firms/contractors that specialize in the installation of HVAC systems. This purpose of this proposal is to provide for the removal and replacement of HVAC Rooftop Units and associated controls for the Boone County Sheriff's Office located at 3000 Conrad Lane, Burlington, KY 41005.

6. PROPOSED SCHEDULE

The County would like to move quickly in selection of a firm to begin the process. The selected firm should be prepared to begin work immediately after a contract is signed with the goal of completing work on an aggressive schedule with a goal of implementation in fall of 2019. This anticipated schedule is negotiable with justification from the consultant.

7. EXPERIENCE AND QUALIFICATIONS

Boone County is seeking a consultant/ firm that can demonstrate the following list of required qualifications:

- A. Must possess a minimum of five (5) years of experience in building automation controls hardware/software installation;
- B. Must possess a minimum of five (5) years of experience rooftop HVAC installation;
- C. Must meet all of the requirements to conduct business in Boone County and the Commonwealth of Kentucky;
- D. Must provide a minimum of three (3) professional references;
- E. Provide locations of three (3) recent projects of similar size and scope.
- F. Must meet all other requirements as outlined in this RFP.

If applicable, the firm should provide a list of potential conflicts of interests due to personal interests or work done for others.

8. MINIMUM REQUIREMENTS TO BE INCLUDED IN SUBMISSION

A. Pricing Proposal.

The proposal must include pricing for all elements listed in this document and highlighted. Proposal pricing shall be:

- 1) Removal of existing units, Replacement of existing units and system start up and balancing.
- 2) Electrical Deduction #1

- a. A per feeder/disconnect cost given back to the Owner whenever the existing rooftop electrical feeders are long enough to reach the new disconnect location without having to be extended.
- b. There are currently two sets of feeders/disconnects for each rooftop unit; one for normal power (condensing units), and the other for emergency power (fans). This means there should be two deductions possible for each rooftop unit.

B. Specifications for hardware and software included in proposal.

A complete set of specifications, cut sheet drawings and information for all hardware and software used to establish the proposal pricing must be included with the proposal submission and as required in the system specifications.

C. References

The submission must also include three references with contact information, any exceptions noted and any conflicts of interest related to this proposed project.

D. Project Timeline

A proposed project timeline for installation must be included with the proposal submission.

E. Firm Information

Signed copy of the proposal Acknowledgement Form (contained within the RFP) and W9 for the company.

F. Warranty and Technical Support

Documentation of hardware/Software warranty and technical support (if available).

G. Insurance Requirements

Certificate of Insurance demonstrating required coverages as listed in section 4.

9. PROPOSAL SUBMISSION, PRE-PROPOSAL MEETING AND RFP INQUIRIES INFORMATION

A. Submission Date and Time: August 20, 2109, at 2:00 p.m. “local time”

The proposal must be submitted to the County Finance Office c/o Purchasing Agent, Second Floor, Administration Building, 2950 Washington Street, Burlington, Kentucky 41005, by the

above referenced submission date and time. Late, electronically submitted or facsimile proposals will not be accepted.

Please clearly mark the submittal with the title of this RFP and the name of the responding firm. Only those responses received prior to or on the submission date and time will be considered.

B. Pre-Proposal Meeting

A **Mandatory Pre-Proposal Meeting** and facility tour will be held on **August 13, 2019, 2019 at 1:00 p.m.** The meeting will be held in the Boone County Sheriff's Office located at 3000 Conrad Road in Burlington, KY 41005.

C. RFP Inquiries

Inquiries/Questions regarding this RFP should be posed in writing no later than August 15th, 2019 and be directed to:

Michael Albrecht, Director of Property Maintenance
malbrecht@boonecountky.org

Answers will be provided as an addendum on the procurement page of the county's website at www.boonecountky.org/publicnotices page by August 16, 2019, if not before that.

10. PROJECT AWARD

Boone County reserves the right to evaluate all submitted proposals and to award the project to the submission deemed to be in the best interest of the county.

The County's selection will be made based on an evaluation using the following criteria, weighted as indicated.

- a) Total cost/value to the County (25%)
- b) Warranty (10%)
- c) Technical Support/Customer Service (5%)
- d) Overall Quality of Proposal (10%)
- e) Schedule Timeline/ Ability to meet deadlines (35%)
- f) Hardware and software meet or exceed specifications (15%)

Total 100%

The Boone County Fiscal Court may, in its sole and absolute discretion, accept or reject, in whole or in part, for any reason whatsoever any or all Proposals; re-advertise this Request for Proposal; postpone or cancel at any time the Proposal process; waive any informalities of or

irregularities in the process; negotiate with any party or request additional information if it so desires.

Proposals that are not submitted on time and/or do not conform to the Boone County Fiscal Courts requirements will not be considered. The County may determine, at its sole discretion, whether any aspect of the proposal satisfies the criteria established in this Proposal. In all cases, the Boone County Fiscal Court shall have no liability to any contractor for any costs or expense, incurred in connection with this proposal or otherwise.

The County will allow a proposer's representative bearing proper authorization and identification to sign for, receive, and withdraw the proposer's unopened proposal prior to submission deadline. A firm wishing to modify his/her proposal may do so by withdrawing the initial submission and then submitting a modified proposal prior to the deadline. Neither the staff nor the facilities of the County will be available to assist a proposer desiring to make modifications. It will be the proposer's responsibility to make all modifications. The County may conduct discussions with persons submitting proposals for the purpose of clarification to assure full understanding of, and responsiveness to, the solicitation requirements.

The County will use the requirements set forth in the RFP as the basis for proposal evaluation. After identification of the responsible institution(s) or whose proposal appears to be most advantageous to the County, the County will enter into contract preparation activities with the proposer. If at any time the contract preparation activities are judged to be ineffective, the County may cease all activities and begin contract preparation activities with the next highest rated proposer, and the process may continue until a contract is executed. The County reserves the right to cease all contract preparation activities at any time and reject all proposals if such action is determined to be in the best interest of the County.

11. REFERENCE TO SPECIFIED EQUIPMENT CLARIFICATION

It should be noted by proposers that with respect to specific models for the specifications that follow for the HVAC Replacement for the Boone County Sheriff's Office Request for Proposals, references to specific models are provided for reference only. The intent of providing such references is to clarify required functionality and features and NOT to require any specific model of equipment. In every instance where a reference is made to a specific brand or model, the RFP should be read to also accept a proposal that includes an equivalent brand or model providing the same function or features.

12. SPECIFICATIONS

Included as Exhibit A

CONTRACTOR BACKGROUND CHECKS

Due to the nature of the building, all contractor staff working in the building will be required to pass a background check provided by County staff.

BUILDING SYSTEMS AVAILABILITY

Due to the nature of the building, all contractor work in the building will be required to limit system downtime to the working day.

CONTRACTOR AVAILABILITY

Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been completed.

CONTRACTOR EQUIPMENT STAGING

Contractor shall be responsible for proper care, storage and staging of all equipment included in the project

DOCUMENTATION

All Owners manuals and or maintenance information shall be provided in printed form (2 copies) as well as electronic PDF format to the owner and owner representative.

WARRANTY AND SUPPORT

Unless otherwise noted, Contractor shall guarantee all materials, equipment, etc., two (2) years from date of final Owner acceptance of system. This guarantee shall include all labor, material and travel time.

13. DRAWINGS

Included as Exhibit B.

14. PERFORMANCE BOND, RETAINAGE & LIQUIDATED DAMAGES

A. Performance Bond

The HVAC Replacement for the Boone County Sheriff’s Office Project will require a 100% performance bond to be presented at the execution of the agreement.

B. Retainage

10% shall be held in retainage until 6 months after installation and start up.

C. Liquidated Damages

Due to the sensitive nature of the project completion this project, liquidated damages in the amount of \$100.00 per day shall apply for each working day past the contracted completion date.

**Terms and Signature Sheet
(Required to be Included with Proposal Submission)**

In compliance with this Proposal and subject to all conditions thereof, the undersigned offers and agrees to furnish any or all items and/or services upon which prices are quoted, at the price quoted as specified.

My signature certifies that the accompanying proposal is not the result of or affected by, any act of collusion with another person or company engaged in the same line of business or commerce, or any act of fraud. I hereby certify that I am authorized to sign this proposal for the Proposer.

NAME OF PROPOSER: _____ DATE: _____

ADDRESS: _____

FEDERAL ID #: _____
(Attached W-9)

SIGNATURE: _____

OFFICIAL TITLE: _____

PHONE (____) _____ FAX (____) _____

KENTUCKY PREFERENCE LAWS

The scoring of proposals is subject to Reciprocal preference for Kentucky resident bidders and Preferences for a Qualified Bidder or the Department of Corrections, Division of Prison Industries.

***Vendors not claiming resident bidder or qualified bidder status need not submit the corresponding affidavit.**

Reciprocal preference for Kentucky resident bidders

KRS 45A.490 Definitions for KRS 45A.490 to 45A.494.

As used in KRS 45A.490 to 45A.494:

- (1) "Contract" means any agreement of a public agency, including grants and orders, for the purchase or disposal of supplies, services, construction, or any other item; and
- (2) "Public agency" has the same meaning as in KRS 61.805.

KRS 45A.492 Legislative declarations.

The General Assembly declares:

- (1) A public purpose of the Commonwealth is served by providing preference to Kentucky residents in contracts by public agencies; and
- (2) Providing preference to Kentucky residents equalizes the competition with other states that provide preference to their residents.

KRS 45A.494 Reciprocal preference to be given by public agencies to resident bidders -- List of states -- Administrative regulations.

- (1) Prior to a contract being awarded to the lowest responsible and responsive bidder on a contract by a public agency, a resident bidder of the Commonwealth shall be given a preference against a nonresident bidder registered in any state that gives or requires a preference to bidders from that state. The preference shall be equal to the preference given or required by the state of the nonresident bidder.
- (2) A resident bidder is an individual, partnership, association, corporation, or other business entity that, on the date the contract is first advertised or announced as available for bidding:
 - (a) Is authorized to transact business in the Commonwealth; and
 - (b) Has for one (1) year prior to and through the date of the advertisement, filed Kentucky corporate income taxes, made payments to the Kentucky unemployment insurance fund established in KRS 341.490, and maintained a Kentucky workers' compensation policy in effect.
- (3) A nonresident bidder is an individual, partnership, association, corporation, or other business entity that does not meet the requirements of subsection (2) of this section.
- (4) If a procurement determination results in a tie between a resident bidder and a nonresident bidder, preference shall be given to the resident bidder.
- (5) This section shall apply to all contracts funded or controlled in whole or in part by a public agency.
- (6) The Finance and Administration Cabinet shall maintain a list of states that give to or require a preference for their own resident bidders, including details of the preference given to such bidders, to be used by public agencies in determining resident bidder preferences. The cabinet shall also promulgate administrative regulations in accordance with KRS Chapter 13A establishing the procedure by which the preferences required by this section shall be given.
- (7) The preference for resident bidders shall not be given if the preference conflicts with federal law.
- (8) Any public agency soliciting or advertising for bids for contracts shall make KRS 45A.490 to 45A.494 part of the solicitation or advertisement for bids.

The reciprocal preference as described in KRS 45A.490-494 above shall be applied in accordance with 200 KAR 5:400.

Determining the residency of a bidder for purposes of applying a reciprocal preference

Any individual, partnership, association, corporation, or other business entity claiming resident bidder status shall submit along with its response the attached Required Affidavit for Bidders, Offerors, and Contractors Claiming Resident Bidder Status. The BIDDING AGENCY reserves the right to request documentation supporting a proposer's claim of resident bidder status. Failure to provide such documentation upon request shall result in disqualification of the bidder or contract termination.

A nonresident bidder shall submit, along with its response, its certificate of authority to transact business in the Commonwealth as filed with the Commonwealth of Kentucky, Secretary of State. The location of the principal office identified therein shall be deemed the state of residency for that bidder. If the bidder is not required by law to obtain said certificate, the state of residency for that bidder shall be deemed to be that which is identified in its mailing address as provided in its bid.

Preferences for a Qualified Bidder or the Department of Corrections, Division of Prison Industries.

Pursuant to 200 KAR 5:410, and KRS 45A.470, Kentucky Correctional Industries will receive a preference equal to twenty (20) percent of the maximum points awarded to a bidder in a solicitation. In addition, the following "qualified bidders" will receive a preference equal to fifteen (15) percent of the maximum points awarded to a bidder in a solicitation: Kentucky Industries for the Blind, any nonprofit corporation that furthers the purposes of KRS Chapter 163 and any qualified nonprofit agencies for individuals with severe disabilities as defined in KRS 45A.465(3). Other than Kentucky Industries for the Blind, a bidder claiming "qualified bidder" status shall submit along with its response to the solicitation a notarized affidavit which affirms that it meets the requirements to be considered a qualified bidder-affidavit form included. If requested, failure to provide documentation to a public agency proving qualified bidder status may result in disqualification of the bidder or contract termination.

**REQUIRED AFFIDAVIT FOR BIDDERS, OFFERORS AND CONTRACTORS CLAIMING
QUALIFIED BIDDER STATUS**

(Not Required Unless Claiming Qualified Bidder Status)

FOR BIDS AND CONTRACTS IN GENERAL:

I. The bidder or offeror swears and affirms under penalty of perjury that the entity bidding, and all subcontractors therein, meets the requirements to be considered a "qualified bidder" in accordance with [200 KAR 5:410\(3\)](#); and will continue to comply with such requirements for the duration of any contract awarded. Please identify below the particular "qualified bidder" status claimed by the bidding entity.

_____ A nonprofit corporation that furthers the purposes of KRS Chapter 163

_____ Per KRS 45A.465(3), a "Qualified nonprofit agency for individuals with severe disabilities" means an organization that:

- (a) Is organized and operated in the interest of individuals with severe disabilities; and
- (b) Complies with any applicable occupational health and safety law of the United States and the Commonwealth; and
- (c) In the manufacture or provision of products or services listed or purchased under KRS 45A.470, during the fiscal year employs individuals with severe disabilities for not less than seventy-five percent (75%) of the man hours of direct labor required for the manufacture or provision of the products or services; and
- (d) Is registered and in good standing as a nonprofit organization with the Secretary of State.

The BIDDING AGENCY reserves the right to request documentation supporting a proposer's claim of qualified bidder status. Failure to provide such documentation upon request may result in disqualification of the bidder or contract termination.

Signature	Printed Name
Title	Date
Company Name	
Address	

Subscribed and sworn to before me by _____ (Affiant) _____ (Title)

of _____ this ____ day of _____, 20__.

(Company Name)

Notary Public

[seal of notary] My commission expires: _____

EXHIBIT A

BOONE COUNTY, KENTUCKY
SHERIFF'S OFFICE

HVAC Replacement

Exhibit A attached as file:

**SPECIFICATIONS FOR THE BOONE COUNTY SHERIFF'S OFFICE
EXHIBIT A**

Exhibit B attached as file:

**DRAWINGS FOR THE BOONE COUNTY SHERIFF'S OFFICE
EXHIBIT B**

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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
 2. Equipment installation requirements common to equipment sections.
 3. Supports and anchorages.

1.2 DEFINITIONS

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

1.3 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing 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.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

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

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- D. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 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.
- 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.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

END OF SECTION 230500

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.

1.2 SUBMITTALS

- A. Specify reports required because of editing procedures in Part 3.
- B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- C. Warranties specified in this Section.

1.3 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB or TABB.
- B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."

1.4 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.5 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Perform TAB after leakage and pressure tests on the air distribution system have been satisfactorily completed.

1.6 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

- F. Examine system and equipment test reports.
- G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- I. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
- B. Cut insulation, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.

5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.9 TOLERANCES

- A. Set HVAC system airflow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.10 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB firm who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.

1.2 SUBMITTALS

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

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.

2.2 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 200 deg F.
 4. Solids Content: 63 percent by volume and 73 percent by weight.
 5. Color: White.

2.3 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 100 to plus 300 deg F.**
5. Color: White or gray.

2.4 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) **<Insert manufacturer's name; product name or designation.>**
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) **<Insert manufacturer's name; product name or designation.>**
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) **<Insert manufacturer's name; product name or designation.>**
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts, and fittings.
- 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 insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire

damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

3.4 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.5 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two locations for each duct system.
 - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed outdoor air.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.

5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- D. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components.
- B. See Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.2 SUBMITTALS

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
 - 1. Thermostats.
 - 2. Damper schedule.
- C. Operation and maintenance data.

1.3 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F.

- C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

2.2 THERMOSTATS

A. Manufacturers:

1. Honeywell.
2. White Rogers.
3. Danfoss Inc.
4. Robert Shaw.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on seven day schedule.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."

2.3 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

- a. Belimo Aircontrols (USA), Inc.
- b. Or approved equal.

2. Dampers: Size for running torque calculated as follows:

- a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
- b. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Power Requirements (Two-Position Spring Return): 120-V ac.
6. Temperature Rating: Minus 22 to plus 122 deg F.

2.4 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify location of thermostats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
- B. Install guards on thermostats in the following locations:
 1. Entrances.
 2. Public areas.
 3. Where indicated.
- C. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

3.2 DEMONSTRATION

- A. Engage a representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. See Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.2 AIR-HANDLING-UNIT CONTROL SEQUENCES

- A. Start and Stop Supply Fan(s):
 - 1. Enable: Freeze Protection:
 - a. Input Device: Duct-mounted averaging element thermostat, located before supply fan.
 - b. Output Device: Hard wired through motor starter; **[analog alarm panel] [DDC system alarm]**.
 - c. Action: Allow start if duct temperature is above **37 deg F**; signal alarm if fan fails to start as commanded.
 - 2. Enable: High-Temperature Protection:
 - a. Input Device: Duct-mounted thermostat, located in return air.
 - b. Output Device: Hard wired through motor starter; **[analog alarm panel] [DDC system alarm]**.
 - c. Action: Allow start if duct temperature is below **300 deg F**.
 - 3. Enable: Smoke Control:
 - a. Input Device: Duct-mounted smoke detector, located in **[return] [supply]** air.
 - b. Output Device: Hard wired through motor starter; **[analog alarm panel] [DDC system alarm]**.
 - c. Action: Allow start if duct is free of products of combustion.
 - 4. Initiate: Occupied Time Schedule:
 - a. Input Device: **[Time clock] [DDC system time schedule]**.
 - b. Output Device: **[Time clock] [Binary output]** to motor starter.
 - c. Action: Energize fan(s).
 - 5. Initiate: Unoccupied Time Schedule:
 - a. Input Device: **[Room thermostat] [DDC system demand]**.
 - b. Output Device: **[Room thermostat] [Binary output]** to motor starter.

- c. Action: Energize fan(s).
6. Unoccupied Ventilation:
 - a. Input Device: [**Time clock and room thermostat**] [**DDC system time schedule and output**].
 - b. Output Device: [**Room thermostat**] [**DDC system binary output**] to motor starter.
 - c. Action: Cycle fan(s) during unoccupied periods.
 7. Display: Supply-fan on-off indication.
- B. Supply Fan(s) Variable-Volume Control:
1. Occupied Time Schedule:
 - a. Input Device: [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Time clock**] [**Binary output**].
 - c. Action: Enable control.
 2. Volume Control:
 - a. Input Device: [**Static-pressure transmitter**] [**Differential-pressure switch**] sensing supply-duct static pressure referenced to conditioned-space static pressure.
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to modulating damper actuator. Set inlet guide vanes to [**minimum**] [**closed**] position when fan is stopped.
 - c. Action: Maintain constant supply-duct static pressure.
 3. Volume Control:
 - a. Input Device: [**Static-pressure transmitter**] [**Differential-pressure switch**] sensing supply-duct static pressure referenced to conditioned-space static pressure.
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
 - c. Action: Maintain constant supply-duct static pressure.
 4. High Pressure:
 - a. Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
 - b. Output Device: [**Receiver controller**] [**DDC system binary output**] to [**alarm panel**] [**motor starter**].
 - c. Action: Stop fan and signal alarm when static pressure rises above excessive-static-pressure set point.
 5. Display:
 - a. Supply-fan-discharge static-pressure indication.
 - b. Supply-fan-discharge static-pressure set point.
 - c. Supply-fan airflow rate.

d. Supply-fan [**inlet vane position**] [**speed**].

C. Start and Stop Return Fan(s):

1. Initiate: Occupied Time Schedule:

- a. Input Device: [**Time clock**] [**DDC system time schedule**].
- b. Output Device: [**Time clock**] [**Binary output**] to motor starter.
- c. Action: Energize fans when supply fans are energized.

2. Initiate: Unoccupied Time Schedule:

- a. Input Device: [**Room thermostat**] [**DDC system demand**].
- b. Output Device: [**Room thermostat**] [**Binary output**] to motor starter.
- c. Action: Energize fans when supply fans are energized.

3. Unoccupied Ventilation:

- a. Input Device: [**Time clock and room thermostat**] [**DDC system time schedule and output**].
- b. Output Device: [**Room thermostat**] [**DDC system binary output**] to motor starter.
- c. Action: Cycle fan(s) during unoccupied periods.

4. Display: Return-fan on-off indication.

D. Return Fan(s) Variable-Volume Control:

1. Occupied Time Schedule:

- a. Input Device: [**Time clock**] [**DDC system time schedule**].
- b. Output Device: [**Time clock**] [**Binary output**].
- c. Action: Enable control.

2. Volume Control:

- a. Input Device: [**Static-pressure transmitter**] [**Differential-pressure switch**] sensing building static pressure referenced to outdoor static pressure.
- b. Output Device: [**Receiver controller**] [**DDC system analog output**] to modulating damper actuator. Set inlet guide vanes to [**minimum**] [**closed**] position when fan is stopped.
- c. Action: Maintain constant building static pressure.

3. Volume Control:

- a. Input Device: [**Static-pressure transmitter**] [**Differential-pressure switch**] sensing building static pressure referenced to outdoor static pressure.
- b. Output Device: [**Receiver controller**] [**DDC system analog output**] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
- c. Action: Maintain constant building static pressure.

4. Display:

- a. Return-air static-pressure indication.
 - b. Return-air static-pressure set point.
 - c. Return-fan airflow rate.
 - d. Return-fan [**inlet vane position**] [**speed**].
 - e. Building static-pressure indication.
 - f. Building static-pressure set point.
- E. Return Fan(s) Variable-Volume Control:
1. Occupied Time Schedule:
 - a. Input Device: [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Time clock**] [**Binary output**].
 - c. Action: Enable control.
 2. Volume Control:
 - a. Input Device: [**Static-pressure transmitter**] [**Differential-pressure switch**] sensing building static pressure referenced to outdoor static pressure.
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to modulating damper actuator. Set inlet guide vanes to [**minimum**] [**closed**] position when fan is stopped.
 - c. Action: Maintain constant building static pressure.
 3. Volume Control:
 - a. Input Device: [**Static-pressure transmitter**] [**Differential-pressure switch**] sensing building static pressure referenced to outdoor static pressure.
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
 - c. Action: Maintain constant building static pressure.
 4. Display:
 - a. Return-fan-discharge static-pressure indication.
 - b. Return-fan-discharge static-pressure set point.
 - c. Return-fan airflow rate.
 - d. Return-fan [**inlet vane position**] [**speed**].
- F. Preheat Coil:
1. Freeze Protection:
 - a. Input Device: Duct-mounted averaging element thermostat, located after preheat coil.
 - b. Output Device: Hard wired through motor starter; [**analog alarm panel**] [**DDC system alarm**].
 - c. Action: Allow start if duct temperature is above **33 deg F**.
 2. Occupied Time Schedule:

- a. Input Device: **[Time clock] [DDC system time schedule]**.
 - b. Output Device: **[Time clock] [Binary output]** to motor starter.
 - c. Action: Energize coil circulating pump(s).
3. **[Supply] [Discharge]-Air Temperature:**
- a. Input Device: **[Time clock and duct-mounted thermostat] [DDC system time schedule and electronic temperature sensor]**.
 - b. Output Device: Modulating control valve.
 - c. Action: Maintain air temperature set point of **55 deg F**.
4. Unoccupied Time Schedule:
- a. Input Device: **[Time clock and duct-mounted thermostat mounted in outdoor air] [DDC system time schedule and outdoor-air temperature]**.
 - b. Output Device: **[Time clock] [Binary output]** to motor starter.
 - c. Action: Energize coil circulating pump(s) when outdoor-air temperature falls below **35 deg F**.
5. Display:
- a. Preheat-coil air-temperature indication.
 - b. Preheat-coil air-temperature set point.
 - c. Preheat-coil pump operation indication.
 - d. Preheat-coil control-valve position.
- G. Mixed-Air Control:
1. Occupied Time Schedule:
 - a. Input Device: **[Time clock] [DDC system time schedule]**.
 - b. Output Device: DDC system output.
 - c. Action: Enable control.
 2. Minimum Position:
 - a. Input Device: **[Time clock] [DDC system time schedule]**.
 - b. Output Device: **[Receiver controller] [DDC system analog output]** to modulating damper actuator(s).
 - c. Action: Open **[minimum outdoor-air dampers] [outdoor-air dampers to minimum position]**.
 3. Heating Reset:
 - a. Input Device: **[Room thermostat] [DDC system software]**.
 - b. Output Device: **[Receiver controller] [DDC system analog output]** to modulating damper actuator(s).
 - c. Action: **[Close minimum outdoor-air dampers] [Set outdoor-air dampers to minimum position]**.
 4. **[Supply] [Mixed]-Air Temperature:**

- a. Input Device: [**Duct-mounted thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to modulating damper actuator(s).
 - c. Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of **55 deg F**.
5. Cooling Reset:
- a. Input Device: Outdoor- and return-air, duct-mounted [**thermostats**] [**electronic temperature sensors**].
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to damper actuator(s).
 - c. Action: Set outdoor-air dampers to minimum position when outdoor-air [**temperature exceeds return-air temperature**] [**enthalpy exceeds return-air enthalpy**].
6. Unoccupied Time Schedule:
- a. Input Device: [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] to modulating damper actuator(s).
 - c. Action: Position outdoor- and relief-air dampers closed and return-air dampers open.
7. Display:
- a. Mixed-air-temperature indication.
 - b. Mixed-air-temperature set point.
 - c. Mixed-air damper position.
- H. Humidifier:
1. Occupied Time Schedule:
 - a. Input Device: [**Time clock**] [**DDC system time schedule**] and airflow switch
 - b. Output Device: DDC system output.
 - c. Action: Enable control.
 2. Humidity:
 - a. Input Device: [**Room humidistat**] [**Return-air, duct-mounted humidistat**] [**DDC system**].
 - b. Output Device: [**Receiver controller**] [**DDC system analog output**] [**enables humidifier**] [**modulates control valve to maintain humidity**] [**cycles pump to maintain humidity**] [**cycles pump and modulates control valve to maintain humidity**] in straight-line relationship for the following conditions:
 - 1) 20 percent when outdoor-air temperature is [**minus 30 deg F**] <Insert temperature>.
 - 2) 40 percent when outdoor-air temperature is [**75 deg F**] <Insert temperature>.

- c. Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of **[55 deg F]** <Insert temperature>.
 3. Display:
 - a. Relative humidity indication.
 - b. Relative humidity set point.
 - c. Relative humidity control-valve position.
- I. Filters: During occupied periods, when fan is running, differential air-pressure transmitters exist.
 1. Occupied Time Schedule:
 - a. Input Device: **[Time clock]** **[DDC system time schedule]**.
 - b. Output Device: **[Electric relay]** **[DDC system output]**.
 - c. Action: Enable control.
 2. Differential Pressure:
 - a. Input Device: **[Differential-pressure switches]** **[Pressure transmitter]**.
 - b. Output Device: **[Analog alarm panel]** **[DDC system alarm]**.
 - c. Action: Signal alarm on low- and high-pressure conditions.
 3. Display:
 - a. Filter air-pressure-drop indication.
 - b. Filter low-air-pressure set point.
 - c. Filter high-air-pressure set point.
- J. Hydronic Heating Coil:
 1. Occupied Time Schedule:
 - a. Input Device: **[Time clock]** **[DDC system time schedule]**.
 - b. Output Device: **[Time clock]** **[Binary output]**.
 - c. Action: Enable control.
 2. **[Supply]** **[Discharge]**-Air Temperature:
 - a. Input Device: **[Duct-mounted thermostat]** **[Electronic temperature sensor]**.
 - b. Output Device: Normally **[open]** **[closed]** modulating control valve.
 - c. Action: Maintain supply-air temperature set point of **55 deg F** .
 3. Temperature Reset:
 - a. Input Device: **[Duct-mounted thermostat]** **[Electronic temperature sensor]** in return air.
 - b. Output Device: **[Direct to receiver controller]** **[DDC system]** in straight-line relationship for the following conditions:

- 1) **[65 deg F]** <Insert temperature> when return-air temperature is **[70 deg F]** <Insert temperature>.
 - 2) **[55 deg F]** <Insert temperature> when return-air temperature is **[75 deg F]** <Insert temperature>.
- c. Action: Reset supply-air temperature set point of **55 deg F**.
4. Unoccupied Time Schedule:
- a. Input Device: **[Time clock and room thermostat]** **[DDC system time schedule and output]**.
 - b. Output Device: **[Room thermostat (cycling fan)]** **[DDC system binary output]**.
 - c. Action: **[Enable normal control]** **[Return valve to normal position]** when fan is cycled on.
5. Display:
- a. Fan-discharge air-temperature indication.
 - b. Fan-discharge air-temperature set point.
 - c. Heating-coil air-temperature indication.
 - d. Heating-coil air-temperature set point.
 - e. Heating-coil pump operation indication.
 - f. Heating-coil control-valve position.
- K. Hydronic Cooling Coil:
1. Occupied Time Schedule:
 - a. Input Device: **[Time clock]** **[DDC system time schedule]**.
 - b. Output Device: **[Time clock]** **[Binary output]**.
 - c. Action: Enable control.
 2. **[Supply]** **[Discharge]**-Air Temperature:
 - a. Input Device: **[Duct-mounted thermostat]** **[Electronic temperature sensor]**.
 - b. Output Device: Normally **[open]** **[closed]** modulating control valve.
 - c. Action: Maintain supply-air temperature set point of **55 deg F**.
 3. Temperature Reset:
 - a. Input Device: **[Duct-mounted thermostat]** **[Electronic temperature sensor]** in return air.
 - b. Output Device: **[Direct to receiver controller]** **[DDC system]** in straight-line relationship for the following conditions:
 - 1) **[65 deg F]** <Insert temperature> when return-air temperature is **[70 deg F]** <Insert temperature>.
 - 2) **[55 deg F]** <Insert temperature> when return-air temperature is **[75 deg F]** <Insert temperature>.
 - c. Action: Reset supply-air temperature set point of **55 deg F**.

4. Unoccupied Time Schedule:
 - a. Input Device: [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Time clock**] [**Binary output**].
 - c. Action: Disable control.

5. Display:
 - a. Fan-discharge air-temperature indication.
 - b. Fan-discharge air-temperature set point.
 - c. Cooling-coil air-temperature indication.
 - d. Cooling-coil air-temperature set point.
 - e. Cooling-coil control-valve position.

- L. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.

- M. Operator Station Display: Indicate the following on operator workstation display terminal:
 1. DDC system graphic.
 2. DDC system on-off indication.
 3. DDC system occupied/unoccupied mode.
 4. Outdoor-air-temperature indication.
 5. Supply-fan on-off indication.
 6. Supply-fan-discharge static-pressure indication.
 7. Supply-fan-discharge static-pressure set point.
 8. Supply-fan airflow rate.
 9. Supply-fan [**inlet vane position**] [**speed**].
 10. Return-fan on-off indication.
 11. Return-air static-pressure indication.
 12. Return-air static-pressure set point.
 13. Return-fan airflow rate.
 14. Return-fan [**inlet vane position**] [**speed**].
 15. Building static-pressure indication.
 16. Building static-pressure set point.
 17. Preheat-coil air-temperature indication.
 18. Preheat-coil air-temperature set point.
 19. Preheat-coil pump operation indication.
 20. Preheat-coil control-valve position.
 21. Mixed-air-temperature indication.
 22. Mixed-air-temperature set point.
 23. Mixed-air damper position.
 24. Relative humidity indication.
 25. Relative humidity set point.
 26. Relative humidity control-valve position.
 27. Filter air-pressure-drop indication.
 28. Filter low-air-pressure set point.
 29. Filter high-air-pressure set point.
 30. Fan-discharge air-temperature indication.
 31. Fan-discharge air-temperature set point.
 32. Heating-coil air-temperature indication.

33. Heating-coil air-temperature set point.
34. Heating-coil pump operation indication.
35. Heating-coil control-valve position.
36. Cooling-coil air-temperature indication.
37. Cooling-coil air-temperature set point.
38. Cooling-coil control-valve position.
39. Room temperature indication.
40. Room temperature set point.

1.3 TERMINAL UNIT OPERATING SEQUENCE

A. Cabinet Unit Heater, Hydronic:

1. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: [**Room thermostat**] [**DDC system binary output**].
 - c. Action: Cycle fan to maintain temperature.
2. Low-Temperature Safety:
 - a. Input Device: Line-voltage, on-off thermostat, pipe mounted.
 - b. Output Device: Hard wired.
 - c. Action: Stop fan when [**return heating-water**] [**condensate**] temperature falls below **35 deg F**.
3. Display:
 - a. Room temperature indication.
 - b. Room temperature set point.

B. Cabinet Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.

C. Unit Heater, Hydronic:

1. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: [**Room thermostat**] [**DDC system binary output**].
 - c. Action: Cycle fan to maintain temperature.
2. Low-Temperature Safety:
 - a. Input Device: Line-voltage, on-off thermostat, pipe mounted.
 - b. Output Device: Hard wired.
 - c. Action: Stop fan when [**return heating-water**] [**condensate**] temperature falls below **35 deg F**.
3. Display:
 - a. Room temperature indication.

- b. Room temperature set point.
- D. Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.
- E. Combustion-Air Unit Heaters:
- 1. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: Electronic control-valve operator.
 - c. Action: Modulate valve to maintain temperature.
 - 2. Display:
 - a. Room temperature indication.
 - b. Room temperature set point.
 - c. Control-valve position.
- F. Radiant Heating Cable, Electric: Room thermostat cycles power.
- G. Radiant Heating Panel, Electric: Room thermostat cycles power.
- H. Radiant Heating Panel, Hydronic:
- 1. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: Electronic control-valve operator.
 - c. Action: Modulate valve to maintain temperature.
 - 2. Display:
 - a. Room temperature indication.
 - b. Room temperature set point.
 - c. Control-valve position.
- I. Two-Pipe, Single-Coil, Fan-Coil Unit:
- 1. Occupied Time Schedule:
 - a. Input Device: [**Fan switch**] [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Time clock**] [**Binary output**].
 - c. Action: Start and stop fan and enable control.
 - 2. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**] in [**room**] [**return air**].
 - b. Output Device: Electronic control-valve operator.
 - c. Action: Modulate valve to maintain temperature.
 - 3. DDC System Changeover:

- a. Input Device: [**Thermostat**] [**Electronic temperature sensor**] [**in supply-water**] [**on supply-water piping**] [**DDC system**].
 - b. Output Device: [**Hard-wired relay**] [**DDC system software**].
 - c. Action: Reverse control-valve action to switch from heating to cooling.
4. Display:
- a. DDC system graphic.
 - b. DDC system on-off indication.
 - c. DDC system occupied/unoccupied mode.
 - d. Room temperature indication.
 - e. Room temperature set point.
 - f. Control-valve position.
 - g. Supply-water temperature indication.
- J. Four-Pipe, Hydronic Fan-Coil Unit:
1. Occupied Time Schedule:
 - a. Input Device: [**Fan switch**] [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Time clock**] [**Binary output**].
 - c. Action: Start and stop fan, and enable control.
 2. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: Electronic control-valve operators.
 - c. Action: Modulate multiport control valves to maintain temperature.
 3. Display:
 - a. DDC system graphic.
 - b. DDC system on-off indication.
 - c. DDC system occupied/unoccupied mode.
 - d. Room temperature indication.
 - e. Room temperature set point.
 - f. Control-valve position.
- K. Unit Ventilator: Room thermostat modulates heating-and-cooling control valves; airstream thermostats modulate outdoor- and return-air dampers as follows:
1. Occupied Time Schedule:
 - a. Input Device: [**Fan switch**] [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Time clock**] [**Binary output**].
 - c. Action: Start and stop fan, move outdoor- and return-air dampers to [**minimum**] [**maximum**] outdoor-air position, and enable control.
 2. Room Temperature - Valves:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].

- b. Output Device: Electronic control-valve operators.
 - c. Action: Modulate heating-water supply control valve and chilled-water supply control valve in sequence to maintain temperature.
 3. Room Temperature - Dampers:
 - a. Input Device: [**Thermostat**] [**Electronic temperature sensor**] in mixed air.
 - b. Output Device: Electronic control damper actuators.
 - c. Action: Modulate outdoor- and return-air dampers to maintain temperature.
 4. Supply-Air Temperature Limit:
 - a. Input Device: [**Thermostat**] [**Electronic temperature sensor**] in discharge air.
 - b. Output Device: Electronic control-valve operators and control damper actuators.
 - c. Action: Override room thermostat to control valves and dampers to prevent discharge air from dropping below a minimum set point.
 5. Warm-up Cycle:
 - a. Input Device: [**Time clock**] [**DDC system time schedule**].
 - b. Output Device: [**Hard-wired relay**] [**DDC system binary output**].
 - c. Action: Open heating-water supply control valve, close outdoor-air damper, and open return-air damper.
 6. Display:
 - a. DDC system graphic.
 - b. DDC system on-off indication.
 - c. DDC system occupied/unoccupied mode.
 - d. Room temperature indication.
 - e. Room temperature set point.
 - f. Control-valve position.
 - g. Damper position.
- L. Heating Coils, Hydronic:
 1. Room Temperature:
 - a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
 - b. Output Device: [**Electronic**] [**Electric**] control-valve operators.
 - c. Action: [**Modulate**] [**Cycle**] valve to maintain temperature.
 2. Display:
 - a. Room temperature indication.
 - b. Room temperature set point.
 - c. Control-valve position.
- M. Heating Coils, Electric: Room thermostat [**cycles coils**] [**sequences stages of heating**].
- N. Radiators and Convectors, Hydronic:

1. Occupancy:
 - a. Input Device: Occupancy sensor.
 - b. Output Device: DDC system binary output.
 - c. Action: Report occupancy and enable occupied temperature set point.
 2. Room Temperature:
 - a. Input Device: **[Room thermostat]** **[Electronic temperature sensor]**.
 - b. Output Device: **[Electronic]** **[Electric]** control-valve operators.
 - c. Action: **[Modulate]** **[Cycle]** valve to maintain temperature.
 - 1) Occupied Temperature: **75 deg F.**
 - 2) Unoccupied Temperature: **65 deg F.**
 3. Display:
 - a. Room/area served.
 - b. Room temperature indication.
 - c. Room temperature set point.
 - d. Room temperature set point, occupied.
 - e. Room temperature set point, occupied standby.
 - f. Room temperature set point, unoccupied.
 - g. Control-valve position as percent open.
- O. Radiators and Convector, Electric: Room thermostat **[cycles coils]** **[sequences stages of heating]**.
- P. Constant-Volume, Terminal Air Units, Hydronic:
1. Occupancy:
 - a. Input Device: Occupancy sensor.
 - b. Output Device: DDC system binary output.
 - c. Action: Report occupancy and enable occupied temperature set point.
 - 1) Occupied Temperature: **75 deg F.**
 - 2) Unoccupied Temperature: **65 deg F.**
 2. Room Temperature:
 - a. Input Device: **[Room thermostat]** **[Electronic temperature sensor]**.
 - b. Output Device: **[Electronic]** **[Electric]** control-valve operators.
 - c. Action: **[Modulate]** **[Cycle]** valve to maintain temperature.
 3. Display:
 - a. Room/area served.
 - b. Room occupied/unoccupied.
 - c. Room temperature indication.
 - d. Room temperature set point.

- e. Room temperature set point, occupied.
- f. Room temperature set point, unoccupied.
- g. Control-valve position as percent open.

Q. VAV, Terminal Air Units with Hydronic Coils:

1. Occupancy:

- a. Input Device: Occupancy sensor.
- b. Output Device: DDC system binary output.
- c. Action: Report occupancy and enable occupied temperature set point.

- 1) Occupied Temperature: 75 deg F.
- 2) Unoccupied Temperature: 65 deg F .

2. Room Temperature:

- a. Input Device: [**Room thermostat**] [**Electronic temperature sensor**].
- b. Output Device: Electronic damper actuators and control-valve operators.
- c. Action: Modulate damper and valve to maintain temperature.

- 1) Sequence damper from full open to minimum position, then valve from closed to fully open.

3. Display:

- a. Room/area served.
- b. Room occupied/unoccupied.
- c. Room temperature indication.
- d. Room temperature set point.
- e. Room temperature set point, occupied.
- f. Room temperature set point, unoccupied.
- g. Air-damper position as percent open.
- h. Control-valve position as percent open.

1.4 VENTILATION SEQUENCES

- A. Exhaust Fan: Interlock with light switch cycles fan.
- B. Kitchen Exhaust Fan: Manual switch starts fan and energizes makeup air unit.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Delegated-Design Submittal: For natural-gas piping and equipment 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. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 106, black steel, Schedule 40.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.3 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.4 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Eaton Corporation; Controls Div.
 - b. Maxitrol Company.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.5 DIELECTRIC UNIONS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 2. Wilkins; Zurn Plumbing Products Group.
- B. Minimum Operating-Pressure Rating: 150 psig.

- C. Combination fitting of copper alloy and ferrous materials.
- D. Insulating materials suitable for natural gas.
- E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.6 LABELING AND IDENTIFYING

- A. All new gas piping should be painted yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- C. Install fittings for changes in direction and branch connections.

3.2 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.3 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.4 HANGER AND SUPPORT INSTALLATION

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

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3.5 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.6 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.7 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

- C. Prepare test and inspection reports.

3.8 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.9 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves in branch piping for single appliance shall be:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-140A:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.

1.3 SUBMITTALS

- A. Drawings indicate the design intent only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.

- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.

2.2 REFRIGERANTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Atofina Chemicals, Inc.
 - 2. DuPont Company; Fluorochemicals Div.
 - 3. Honeywell, Inc.; Genetron Refrigerants.
 - 4. INEOS Fluor Americas LLC.
- C. ASHRAE 34, R-410A: Monochlorodifluoromethane.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. 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.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping adjacent to machines to allow service and maintenance.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.

- I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- J. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- K. Install refrigerant piping in protective conduit where installed belowground.
- L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- M. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- N. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- P. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- Q. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

3.2 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.3 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.5 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

- a. Supply Ducts (except in Mechanical Rooms): 1-inch wg.
- b. Supply Ducts (Upstream from Air Terminal Units): 2-inch wg.
- c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
- d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
- e. Return Ducts (Negative Pressure): 1-inch wg.
- f. Exhaust Ducts (Negative Pressure): 1-inch wg.

2. Leakage Class:

- a. Round Supply-Air Duct: **3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa).**
- b. Rectangular Supply-Air Duct: **6 cfm/100 sq. ft. at 1-inch wg (0.29 L/s per sq. m at 250 Pa) .**
- c. Flexible Supply-Air Duct: **6 cfm/100 sq. ft. at 1-inch wg (0.29 L/s per sq. m at 250 Pa) .**

3. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
- D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- E. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- 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.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 SEAM AND JOINT SEALING

- A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.
- B. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with 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.

3.5 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as follows:
- B. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
- C. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows,[12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.

b. Velocity 1000 to 1500 fpm: Conical tap.

c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Fire dampers.
 - 3. Turning vanes.
 - 4. Duct-mounted access doors.
 - 5. Flexible connectors.
 - 6. Flexible ducts.
 - 7. Duct accessory hardware.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - e. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
 - 2. Standard leakage rating.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.

- d. Galvanized-steel, 0.064 inch thick.
 - e. Blade Axles: Galvanized steel .
6. Tie Bars and Brackets: Galvanized steel.

2.3 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Arrow United Industries; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. McGill AirFlow LLC.
 - 6. METALAIRE, Inc.
 - 7. Nailor Industries Inc.
 - 8. NCA Manufacturing, Inc.
 - 9. PHL, Inc.
 - 10. Pottorff; a division of PCI Industries, Inc.
 - 11. Prefco; Perfect Air Control, Inc.
 - 12. Ruskin Company.
 - 13. Vent Products Company, Inc.
 - 14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: To meet penetration requirements.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
- 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable rated, fusible links.

- K. Heat-Responsive Device: Resettable link and switch package, factory installed.

2.4 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Double wall.

2.5 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Flexmaster U.S.A., Inc.
 - 5. Greenheck Fan Corporation.
 - 6. McGill AirFlow LLC.
 - 7. Nailor Industries Inc.
 - 8. Pottorff; a division of PCI Industries, Inc.
 - 9. Ventfabrics, Inc.
 - 10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:

- a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches[**with outside and inside handles**].
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.6 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Ductmate Industries, Inc.
 2. Flame Gard, Inc.
 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.7 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.

- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.8 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
- C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.9 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. In Type I kitchen exhaust ducts as required by code..
 2. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- J. Install flexible connectors to connect ducts to equipment.
- K. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect diffusers or light troffer boots to low-pressure ducts with a rigid 90 degree elbow and a maximum 60-inch lengths of flexible duct clamped or strapped in place.
- M. Install duct test holes where required for testing and balancing purposes.
- N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Linear slot diffusers.
5. Adjustable bar registers.
6. Fixed face registers.

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Hart & Cooley Inc.
 - e. Krueger.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.

- h. Price Industries.
 - i. Titus.
 - j. Tuttle & Bailey.
- 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Mounting: T-bar.
 - 5. Pattern: Fixed.
 - 6. Dampers: Butterfly.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. METALAIRE, Inc.
 - h. Nailor Industries Inc.
 - i. Price Industries.
 - j. Titus.
 - k. Tuttle & Bailey.
- 2. Material: Steel.
- 3. Finish: Baked enamel, white.
- 4. Face Blade Arrangement: Horizontal spaced 1/2 inch apart.
- 5. Rear-Blade Arrangement: Vertical.
- 6. Frame: 1 inch wide.
 - a. Damper Type: Adjustable opposed blade.

B. Adjustable Bar Grille:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. METALAIRE, Inc.
 - h. Nailor Industries Inc.
 - i. Price Industries.

- j. Titus.
- k. Tuttle & Bailey.

- 2. Material: Steel.
- 3. Finish: Baked enamel, white.
- 4. Face Blade Arrangement: Horizontal spaced 1/2 inch apart.
- 5. Rear-Blade Arrangement: Vertical.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Electric-heating coils.
 - 3. Gas furnace.
 - 4. Economizer outdoor- and return-air damper section.
 - 5. Integral, space temperature controls.
 - 6. Roof curbs.

1.2 DEFINITIONS

- A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- B. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- C. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- D. VVT: Variable-air volume and temperature.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

- E. Warranty.

1.4 QUALITY ASSURANCE

- A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

- B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

- D. UL Compliance: Comply with UL 1995.

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

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. AAON, Inc.
2. Addison Products Company.
3. Carrier Corporation.

4. Engineered Air.
5. Lennox Industries Inc.
6. McQuay International.
7. Trane; American Standard Companies, Inc.
8. YORK International Corporation.

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
- C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 1. Materials: ASTM C 1071, Type I.
 2. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 3. Liner Adhesive: Comply with ASTM C 916, Type I.
- D. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.
 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 2. Drain Connections: Threaded nipple both sides of drain pan.
 3. Pan-Top Surface Coating: Corrosion-resistant compound.

2.3 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.
- D. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.

B. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - a. **[Magnetic] [Mercury]** contactors.
 - b. Step Controller: Pilot lights and override toggle switch for each step.
 - c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - d. Time-delay relay.
 - e. Airflow proving switch.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

B. Refrigeration Specialties:

1. Refrigerant Charge: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated: Minimum 90 percent arrestance, and MERV 7.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel with a minimum thermal efficiency of 80 percent.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Safety Controls:
 - 1. Gas Control Valve: [**Single stage**] [**Two stage**] [**Modulating**].
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with [**manual**] [**motorized**] damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - 1. Damper Motor: Modulating with adjustable minimum position.
 - 2. Relief-Air Damper: Gravity actuated with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. Basic Unit Controls:
 - 1. Control-voltage transformer.
 - 2. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Degree F indication.
 - g. Unoccupied-period-override push button.
 - h. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
- C. Electronic Controller:
 - 1. Controller shall have volatile-memory backup.
 - 2. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
 - b. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section "Fire Detection and Alarm."
 - 3. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
 - 4. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure.
 - b. Unoccupied Periods: Compressors off.
 - 5. Gas Furnace Operation:
 - a. Occupied Periods: Stage burner to maintain room temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
 - 6. Electric-Heating-Coil Operation:
 - a. Occupied Periods: Stage coil to maintain room temperature.

- b. Unoccupied Periods: Energize coil to maintain setback temperature.
7. Fixed Minimum Outdoor-Air Damper Operation:
- a. Occupied Periods: Open to scheduled percentage.
 - b. Unoccupied Periods: Close the outdoor-air damper.
8. Economizer Outdoor-Air Damper Operation:
- a. Occupied Periods: Open to scheduled percentage fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. During economizer cycle operation, lock out cooling.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 - c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature.
9. VVT Relays:
- a. Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Division 23 Sections "Air Terminal Units" and "Instrumentation and Control for HVAC."

2.11 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Coil guards of painted, galvanized-steel wire.
- D. Hail guards of galvanized steel, painted to match casing.
- E. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.12 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

- a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1 inch.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
- a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 14 inches.
- D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment Mounting: Install RTUs on concrete base using [**elastomeric pads**] [**elastomeric mounts**] [**restrained spring isolators**] <Insert device>. Comply with requirements for concrete base specified in Division 03 Section "[**Cast-in-Place Concrete**] [**Miscellaneous Cast-in-Place Concrete**]."
1. Minimum Deflection: [**1/4 inch (6 mm)**] [**1 inch (25 mm)**] <Insert dimension>.
- B. Roof Curb: Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- C. Unit Support: Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- D. Install wind and seismic restraints according to manufacturer's written instructions.
- E. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- F. Install piping adjacent to RTUs to allow service and maintenance.
1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and

connect with union and shutoff valve with sufficient clearance for burner removal and service.

- G. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Install ducts to termination at top of roof curb.
 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
 4. Install return-air duct continuously through roof structure.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.3 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 237413

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.2 SUBMITTALS

- A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Operation and maintenance data.

1.3 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. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Units shall be designed to operate with HCFC-free refrigerants.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Carrier Air Conditioning; Div. of Carrier Corp.
2. First Co.
3. Friedrich Air Conditioning Company.
4. Lennox Industries Inc.
5. Sanyo Fisher (U.S.A.) Corp.
6. Trane Co. (The); Unitary Products Group.
7. York International Corp.

2.2 EVAPORATOR-FAN UNIT

- A. Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 1. Insulation: Faced, glass-fiber duct liner.
 2. Drain Pans: Galvanized steel, with connection for drain; insulated.
- B. Floor-Mounting, Unit Cabinet: Enameled steel with removable panels on front and ends.
 1. Discharge Grille: Steel with surface-mounted frame.
 2. Insulation: Faced, glass-fiber, duct liner.
 3. Drain Pans: Galvanized steel, with connection for drain; insulated.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- D. Water Coil: Copper-tube water coil, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a 2-position control valve.
- E. Electric Coil: Helical, nickel-chrome, electric-resistance heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- F. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
- G. Fan Motor: Multispeed.
- H. Filters: 1 inch thick, in fiberboard frames.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

- A. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed compressor with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Aluminum-propeller type, directly connected to motor.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Low Ambient Kit: Permits operation down to 45 deg F.
- H. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- B. Install ground-mounted, compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- D. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Anchor units to supports with removable, cadmium-plated fasteners.

3.2 CONNECTIONS

- A. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- B. Connect supply and return water coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
- C. Connect supply and return condenser connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

- D. Install piping adjacent to unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- B. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 238126

SECTION 260100 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. All provisions of the Bidding Requirements, General Conditions, Supplementary Conditions and Division 1 apply to work specified in this Division.
- B. The Electrical and Mechanical drawings and specifications assign work (labor and/or materials) to be provided by the General, Electrical, Plumbing, Fire Suppression or HVAC Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.2 SCOPE OF WORK

- A. The scope of the electrical work includes furnishing, installing, testing and warranty of all electrical work and complete electrical systems shown on the electrical drawings and specified herein.

1.3 PERMITS AND REGULATIONS

- A. Include payment of all permit and inspection fees applicable to the work in this Division. Furnish for the Owner a certificate of approval from the governing inspection agencies, as a condition for final payment.
- B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.
- C. All electrical work shall be inspected and approved by the local jurisdictional authority.
- D. Include payment for all aid-to-construction cost incurred during this project due to work performed by all Utility Companies.

1.4 INSPECTION OF SITE

- A. Each bidder shall inspect the project site. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having equipment, wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install equipment, wireways, fittings and equipment.
- D. The Architect or Engineer shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.
- E. Equipment, ductwork and piping shall not be installed in the space above electrical switchgear, motor control centers or panelboards as identified by NEC Article 384. The Electrical Contractor shall caution other trades to comply with this stipulation.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of bus duct, conduit, etc., where conflict arises.
- G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. This Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.
- I. If at any time during or before the initial conduit installation the conduit is believed to be undersized, or routed improperly to accommodate the number of conductors and allow for wire pulling. Advise the Owners Representative.

1.6 INSPECTION

- A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

- B. Final inspection certificates shall be obtained by the Contractor and given to the Owner.

1.7 RECORD DRAWINGS

- A. The Electrical Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.
- B. Record drawings shall indicate the following:
 - 1) Size, type, capacity, etc. of any material, device or piece of equipment.
 - 2) Location of any device or piece of equipment.
 - 3) Location of any outlet or source in building service system.
 - 4) Routing of any conduit, ducts or other building services.

1.8 OPERATING AND MAINTENANCE MANUALS

- A. Three copies each of operating and maintenance manuals shall be assembled for the Electrical work by the Contractor.
- B. All shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Major items of equipment shall consist of not less than the following:
 - 1) Transformers.
 - 2) Distribution switchboard and panelboards.
 - 3) Specialty equipment.
 - 4) Fire alarm, communications and sound systems.
- C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.
- D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.9 FINAL INSPECTION AND PUNCH LIST

- A. As the time of work completion approaches, the Contractor shall survey and inspect his work and develop his own punch list to confirm that it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.
- B. Requests to the Architect, Engineer or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

- C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.10 WARRANTY

- A. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to, motor controller malfunction, heater element changes required for motor controller, fuse replacement where fuses blow due to abnormal shorts, adjustments and/or replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.
- C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.
- D. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.
- B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 REFERENCE MATERIALS

- A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.3 EQUIPMENT SELECTION

- A. The selection of materials and equipment to be furnished under this contract shall be governed by the following:

- 1) Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
 - 2) Where the words "or approved equal" appear after a manufacturer's name, specific written approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 - 3) Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
- B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- C. Before bidding equipment, and again in the preparation of shop drawings, the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.
- D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment or existing site conditions which are not compatible with the layout shown on the drawings, necessary changes by all other trades shall be deemed to be included in the contract.

2.4 SHOP DRAWINGS

- A. A digital set of shop drawings and descriptive information shall be assembled by each Contractor of equipment and materials furnished in his contract, and submitted to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings. These shall be submitted as soon as practicable and before special equipment is manufactured and before installation.
- B. The review of shop drawings by the Architect or Engineer shall not relieve the Electrical Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.
- C. Shop drawings of the following equipment and materials shall be submitted:
- 1) Wireway.
 - 2) Wiring devices and coverplates.
 - 3) Panelboards, including short circuit and coordination study.
 - 4) Cabinets and enclosures.
 - 5) Fuses.
 - 6) Fire alarm system including schematic and point to point wiring diagrams.

PART 3 - EXECUTION

3.1 TESTING

- A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.
- B. As each electrically operated system is energized, it shall be tested for function.
- C. On all electric services including change-outs, backfeeds, etc. the Contractor shall verify phase rotation and voltage readings to assure the final installation is proper. Submit to the Engineer in writing a record of voltage readings and current readings taken at no-load and fully loaded conditions.
- D. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.
- E. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Submit four (4) copies of reports indicating results.
- F. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder where appropriate. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests.
- G. Instruments required for tests shall be furnished by the Contractor.

3.2 EQUIPMENT CLEANING

- A. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be performed in accordance with equipment manufacturer's recommendations.
- B. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3.3 OPERATION AND ADJUSTMENT OF EQUIPMENT

- A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents, verifying phase rotation, setting breakers, relays and timers, and adjusting all operating equipment.
- B. Caution: Verify that all bearings of equipment furnished are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the other trades judgment in these matters. Follow specific instructions in regard to lubrication of equipment furnished under this Contract.

3.4 OPERATING DEMONSTATION INSTRUCTIONS

- A. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.
- B. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.
- C. A minimum of 24 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
 - 1) Show location of items of equipment and their purpose.
 - 2) Review binder containing instructions and equipment and systems data.
 - 3) Coordinate written and verbal instructions so that each is understood by personnel.
 - 4) Separate instructions shall be given by manufacturer's representatives for the various special and communications systems
- D. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

END OF SECTION 260100

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathways and cables.
2. Sleeve seals.
3. Grout.
4. Common communications installation requirements.

1.2 SUBMITTALS

A. Product Data: For sleeve seals.

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.
 3. Pressure Plates: Plastic, Carbon steel . Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.

- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 270500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Aluminum and Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, XHHW, UF, USE, and SO.
- C. Multiconductor Cable: Comply with NEMA WC 70 for armored cable (Type AC), metal-clad cable (Type MC), mineral-insulated, metal-sheathed cable (Type MI), nonmetallic-sheathed cable, (Type NM), Type SO and Type USE with ground wire.

2.2 CONNECTORS AND SPLICES

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

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.
 5. Tyco Electronics Corp.
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- D. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 1 AWG (130A & Lower); copper or aluminum for feeders No. 2/0 AWG (135A & Higher) and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway, Type SE.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway, Armored cable, (Type AC), Metal-clad cable (Type MC), Mineral-insulated, metal-sheathed cable, (Type MI), Nonmetallic-sheathed cable, Type NM.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway, Armored cable (Type AC), Metal-clad cable (Type MC), Mineral-insulated, metal-sheathed cable, (Type MI), Nonmetallic-sheathed cable, (Type NM).
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway, Armored cable (Type AC), Metal-clad cable (Type MC), Mineral-insulated, metal-sheathed cable (Type MI), Nonmetallic-sheathed cable (Type NM).
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Armored cable (Type AC), Metal-clad cable (Type MC), Mineral-insulated, metal-sheathed cable (Type MI), Nonmetallic-sheathed cable (Type NM).
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway, Underground branch-circuit in conduit.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway or Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- F. 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.
- G. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- H. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches** of slack.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- D. Cut sleeves to length for mounting flush with both wall surfaces.
- E. Extend sleeves installed in floors 2 inches above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint.

- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials.
- J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.

3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
- B. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- C. Grounding and Bonding for Piping:
1. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.

- a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

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

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel, set-screw type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Hinged type.
- F. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Standard enamel finish.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- G. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: IMC.
 2. Concealed Conduit, Aboveground: IMC.
 3. Underground Conduit: RNC, Type EPC-40 PVC, direct buried.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: Rigid steel conduit.
 7. Raceways for Optical Fiber or Communications Cable: EMT.
 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- K. Raceways for Optical Fiber and Communications Cable: Install as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet .
 - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- O. Set metal floor boxes level and flush with finished floor surface.

- P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for conductors and communication and control cable.
 - 2. Warning labels and signs.
 - 3. Equipment identification labels.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Fasteners for Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
- F. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 mm)."

2.3 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Auxiliary Electrical Systems Conductor and Cable Identification: Use marker tape to identify field-installed alarm, control, signal, sound, intercommunications, voice, and data wiring connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
 - 2. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
- B. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

- a. Power transfer switches.
 - b. Controls with external control power connections.
2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
 - c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Electrical switchgear and switchboards.
 - c. Transformers.
 - d. Disconnect switches.
 - e. Enclosed circuit breakers.
 - f. Motor starters.
 - g. Push-button stations.
 - h. Contactors.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied.
 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

END OF SECTION 260553

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
- C. Field quality-control reports.
- D. Panelboard schedules for installation in panelboards.
- E. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush and surface mounted cabinets.
 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Bottom.
- C. Phase, Neutral, and Ground Buses: Tin-plated aluminum.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Tin-plated aluminum.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus Configured Terminators: Mechanical type.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices: Fused switches.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.

- E. Install filler plates in unused spaces.
- F. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Communications outlets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 3. Description: Single pole, with factory-supplied key in lieu of switch handle.
- D. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.

2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Steel with white baked enamel,
 3. Material for Unfinished Spaces: Galvanized steel.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide General Electric Company; GE Consumer & Industrial - Electrical Distribution or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric.
 4. Approved Equal.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Suitable for number, size, and conductor material.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide General Electric Company; GE Consumer & Industrial - Electrical Distribution or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric.
 4. Approved Equal.
- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- C. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Lugs: Suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide General Electric Company; GE Consumer & Industrial - Electrical Distribution or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. Siemens Energy & Automation, Inc.
 - 3. Square D; a brand of Schneider Electric.
 - 4. Approved Equal.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings,

push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

3.2 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

END OF SECTION 262816

SECTION 268000 - FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Automatic smoke and heat detectors.
- B. Fire alarm signaling appliances.
- C. Auxiliary fire alarm equipment.
- D. Monitor/control modules.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. NFPA 72 – National Fire Code.
- C. NFPA 101 - Life Safety Code.

1.3 SYSTEM DESCRIPTION

- A. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system with connections to central station.

1.4 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Shop Drawings: Provide annunciator layout and system wiring diagram showing each device and wiring connection required.
- C. Product Data: Provide electrical characteristics and connection requirements.
- D. Test Reports: Indicate satisfactory completion of required tests and inspections.
- E. 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 products.
- F. The EC shall be responsible for providing a digital copy of fire alarm systems drawings bearing a stamp, seal and signature from a licensed Professional Engineer shall be provided to the local authority having jurisdiction for approval of the complete fire alarm system. These drawing shall show location of devices with cabling used, and cut sheets which describe each device used with technical data for each device. The EC shall obtain approval from local authority and state factory and buildings prior to rough-in or installation.
- G. Drawings from this office show only the intent and performance of the design for the fire alarm system. Drawings which show the entire fire alarm system with all the required components shall be submitted for approval.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1.
- B. Record actual locations of initiating devices, signaling appliances, and end-of-line devices.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 1.
- B. Operation Data: Operating instructions.
- C. Maintenance Data: Maintenance and repair procedures.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience, and hold a current certification by State of Ohio as fire alarm installer.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, NFPA 101, and NFPA 72.
- B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of fire alarm system for one year from Date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish under provisions of Division 1.
- B. Provide six keys of each type.
- C. Provide three of each type of automatic smoke detector without base.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Match existing system in building, Fire Control Instruments.
- B. Substitutions: Not permitted.

2.2 INITIATING DEVICES

- A. Spot Heat Detector: Fixed temperature, 135 degrees F, and temperature rate of rise of 15 degrees F.
- B. Duct Mounted Smoke Detector: NFPA 72, photoelectric type with programmable relay contact, remote-test switch, duct sampling tubes extending width of duct, and visual indication of detector actuation, in duct-mounted housing. Provide four-wire detector with separate power supply and signal circuits.
- C. Control and relay modules: Relay modules shall be form C dry contact for activation of fan shut down, dampers and any control equipment. Addressable control module shall be for notification of appliances.
- D. Monitor module: Shall supervise a dry circuit input such as tamper, water fans, PLV, etc.

2.3 SIGNALING APPLIANCES

- A. Alarm Chimes: NFPA 72, electric type other single stroke or vibrating. Sound Rating: adjustable up to 83 dBA peak. Provide integral strobe lamp and flasher with red lettered "FIRE" on clear lens.

2.4 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Section 16123.
- B. Initiating Device and Indicating Appliance Circuits: Power limited fire-protective signaling cable classified for fire and smoke characteristics, copper conductor, 300 volts insulation rated 105 degrees C, suitable for use in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Use 16 AWG minimum size conductors for fire alarm detection and signal circuit conductors. Install wiring in conduit.
- C. Mount end-of-line device or separate box adjacent to last device in circuit.
- D. Make conduit and wiring connections to duct smoke detectors and post indicator valves. Coordinate with sprinkler system supplier for exact location and quantity of sprinkler system components.
- E. Automatic Detector Installation: Conform to NFPA 72.
- F. Provide final calculations to verify coverage of room/space initiating devices.
- G. Provide all power circuits required for a complete and functional fire alarm system.

- H. Coordinate fire alarm interface and interconnections with all other trades.

3.2 FIELD QUALITY CONTROL

- A. This contractor shall provide and submit a riser diagram for the system and it shall be approved by State Factory and Buildings and local fire department prior to rough in or installation.
- B. This contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test, or from the date of first beneficial use. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year for a period of five years in compliance with NFPA-72 guidelines. The manufacturers' authorized representative shall provide offsite supervision of installation.
- C. This contractor shall fully test the fire alarm system in accordance with NFPA-72 in the presence of the Owner's representative and the local Fire Marshall. Upon completion of a successful test, the contractor shall so certify in writing to the Owner and General Contractor.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section Division 1.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing. Include adequate time for complete testing and programming of entire system.

3.4 FIRE ALARM WIRE AND CABLE COLOR CODE

- A. Provide fire alarm circuit conductors with insulation color coded as follows, or using colored tape at each conductor termination and in each junction box.

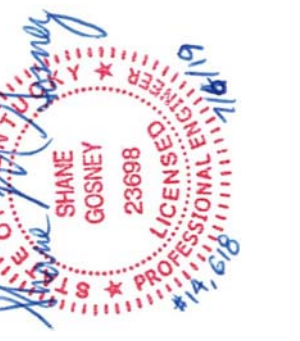
3.5 DEMONSTRATION

- A. Provide systems demonstration under provisions of Division 1.
- B. Demonstrate normal and abnormal modes of operation, and required responses to each.

END OF SECTION 268000

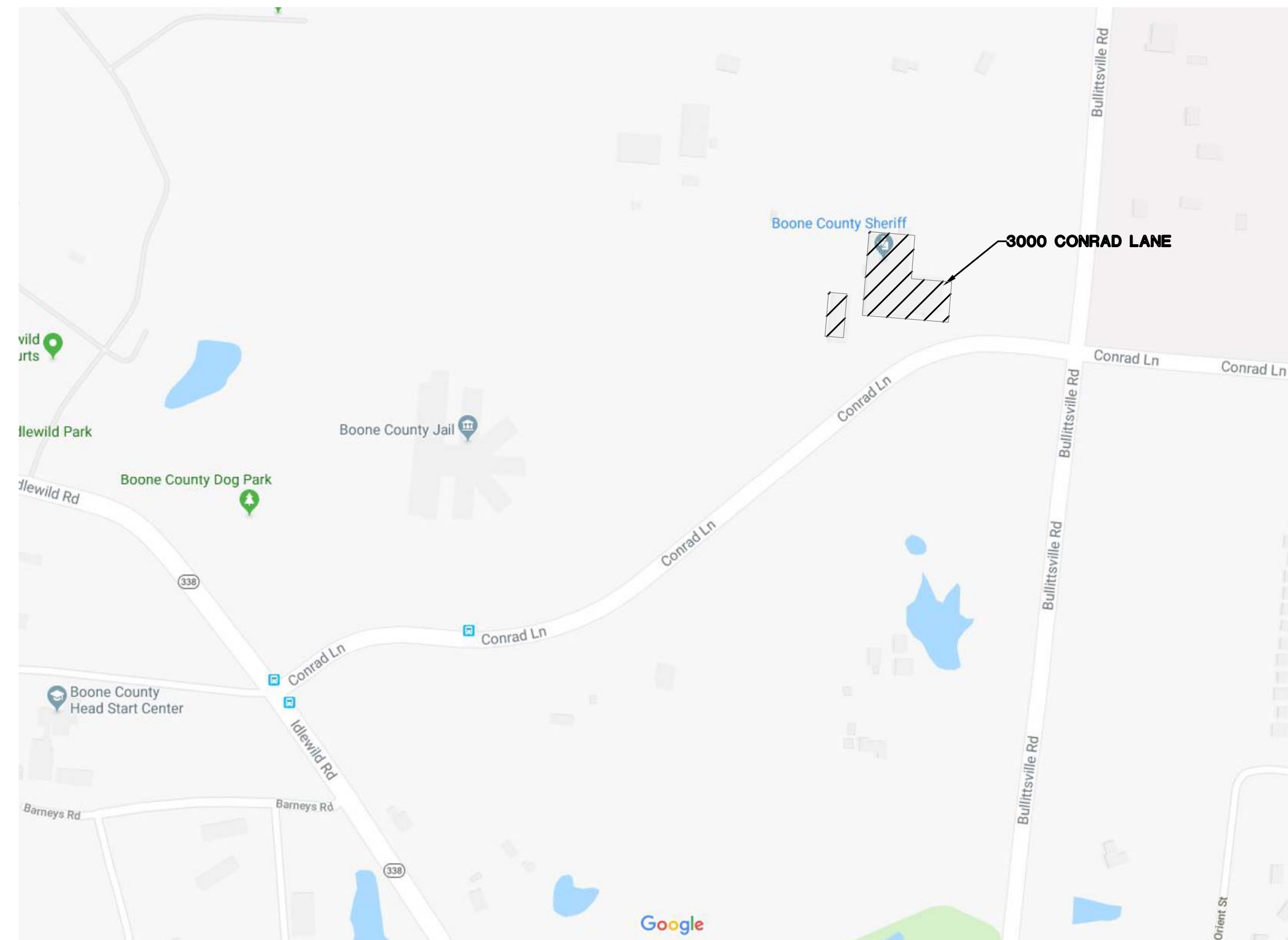
HVAC REPLACEMENT FOR THE BOONE COUNTY SHERIFF'S OFFICE

3000 CONRAD LANE
BURLINGTON, KY



DRAWING INDEX

- M-0.0 COVER SHEET
- M-1.0 AREA 1 HVAC DEMO PLAN
- M-1.1 AREA 2 HVAC DEMO PLAN
- M-1.2 AREA 3 HVAC DEMO PLAN
- M-2.0 AREA 1 HVAC FLOOR PLAN
- M-2.1 AREA 2 HVAC FLOOR PLAN
- M-2.2 AREA 3 HVAC FLOOR PLAN
- M-2.3 HVAC ROOF PLAN
- M-3.0 HVAC NOTES AND SCHEDULES
- M-4.0 HVAC CONTROL DETAILS
- M-4.1 HVAC CONTROL DETAILS
- E-1.0 AREA 1 ELECTRIC FLOOR PLAN
- E-1.1 AREA 2 ELECTRIC FLOOR PLAN
- E-1.2 AREA 3 ELECTRIC FLOOR PLAN
- E-1.3 ELECTRIC ROOF PLAN
- E-2.0 ELECTRICAL EXISTING SINGLE LINE & SCHEDULES
- E-2.1 ELECTRICAL REVISED SINGLE LINE & SCHEDULES
- E-2.2 ELECTRICAL SCHEDULES AND CALCULATIONS

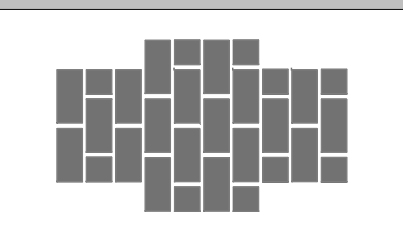


VICINITY MAP
NOT TO SCALE

HVAC LEGEND

	EXISTING RECTANGULAR DUCTWORK AND SIZE		2' x 2' CEILING DIFFUSER
	NEW RECTANGULAR DUCTWORK AND SIZE		2' x 2' EGGRATE RETURN OR TRANSFER GRILLE
	EXISTING ROUND DUCTWORK AND SIZE		1' x 1' CEILING DIFFUSER
	NEW ROUND DUCTWORK AND SIZE		EXHAUST GRILLE
	SPIN-IN W/SCOOP AND DAMPER		DUCT MOUNTED SUPPLY GRILLE
	EXISTING FLEXIBLE DUCTWORK AND SIZE		SIDEWALL MOUNTED SUPPLY REGISTER
	NEW FLEXIBLE DUCTWORK AND SIZE		SIDEWALL MOUNTED RETURN OR TRANSFER REGISTER
	THERMOSTAT		CEILING DIFFUSER, NECK SIZE, AND CFM
	CONNECT NEW TO EXISTING		RETURN GRILLE AND DUCT SIZE
	DENOTES NEW ITEM		TRANSFER GRILLE AND DUCT SIZE
	DENOTES ITEM TO BE REMOVED		EXHAUST GRILLE, FACE SIZE, AND CFM
	DENOTES ITEM TO BE REMOVED		SUPPLY REGISTER, FACE SIZE, AND CFM
	HVAC DRAWING NOTE TAG		RETURN REGISTER AND FACE SIZE
			CONSTANT AIR VOLUME
			VARIABLE AIR VOLUME

HAL-PE ASSOCIATES
ENGINEERING SERVICES, INC.
530 W. 9TH ST.
NEWPORT, KY 41071
859.431.6083
halpe.com



REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE: **COVER SHEET**

DRN: SMG CHK: SMG CAD REF: 14618M-1

DATE: 07-05-19 JOB NO. 14618

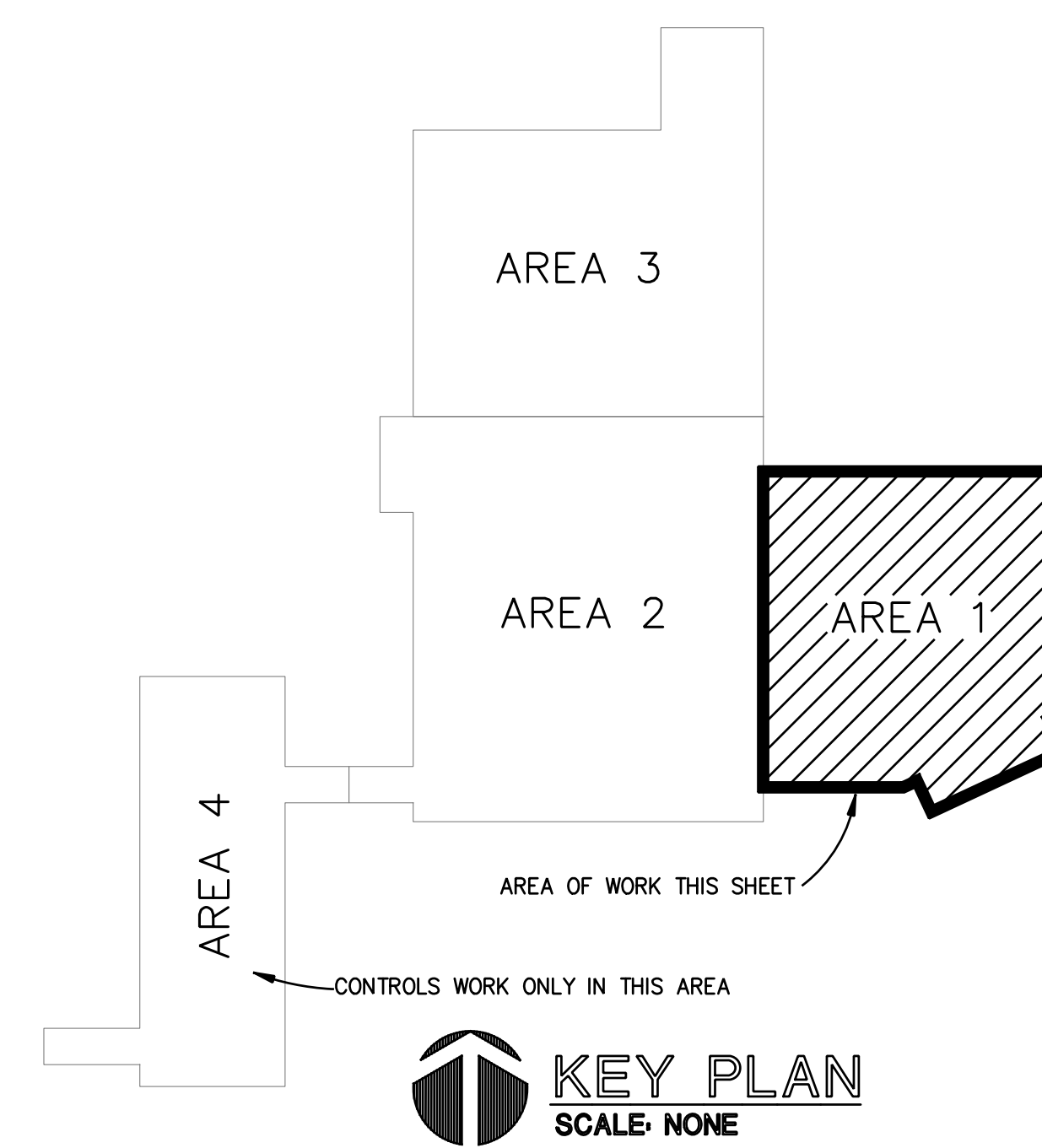
SHEET No.: **M-0.0**

○ HVAC DEMO NOTES - SHEET M-1.0 ONLY

1. EXISTING ROOFTOP UNIT AND ISOLATION RAIL TO BE REMOVED.
2. EXISTING VVT TERMINAL AND CONTROLS TO BE REMOVED.
3. EXISTING VVT BYPASS TERMINAL AND DUCTWORK TO BE REMOVED.
4. REMOVE EXISTING DUCT AS SHOWN.
5. REMOVE EXISTING DUCT AND REGISTER.
6. EXISTING DUCTLESS FAN COIL TO REMAIN, PAIRED WITH EXISTING CU-2 ON ROOF.



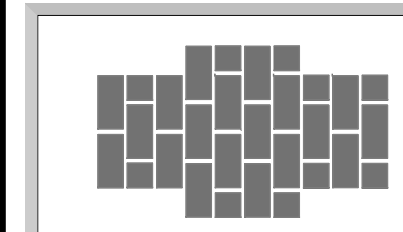
AREA 1 - HVAC DEMOLITION PLAN
SCALE: 1/8" = 1'-0"



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HAL-PE ASSOCIATES
ENGINEERING SERVICES, INC.
530 W. 9TH ST.
NEWPORT, KY 41071
859.431.6083
halpe.com



REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

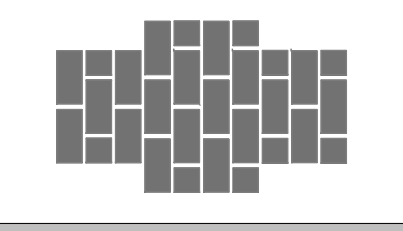
SHEET TITLE: **AREA 1 - HVAC DEMOLITION PLAN**

DRN: SMG
CHK: SMG
CAD REF: 14618M-1
DATE: 07-05-19
JOB NO.: 14618
SHEET No.: **M-1.0**

ISSUED FOR BIDDING



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 ENGINEERING SERVICES, INC.
 530 W. 9TH ST.
 NEWPORT, KY 41071
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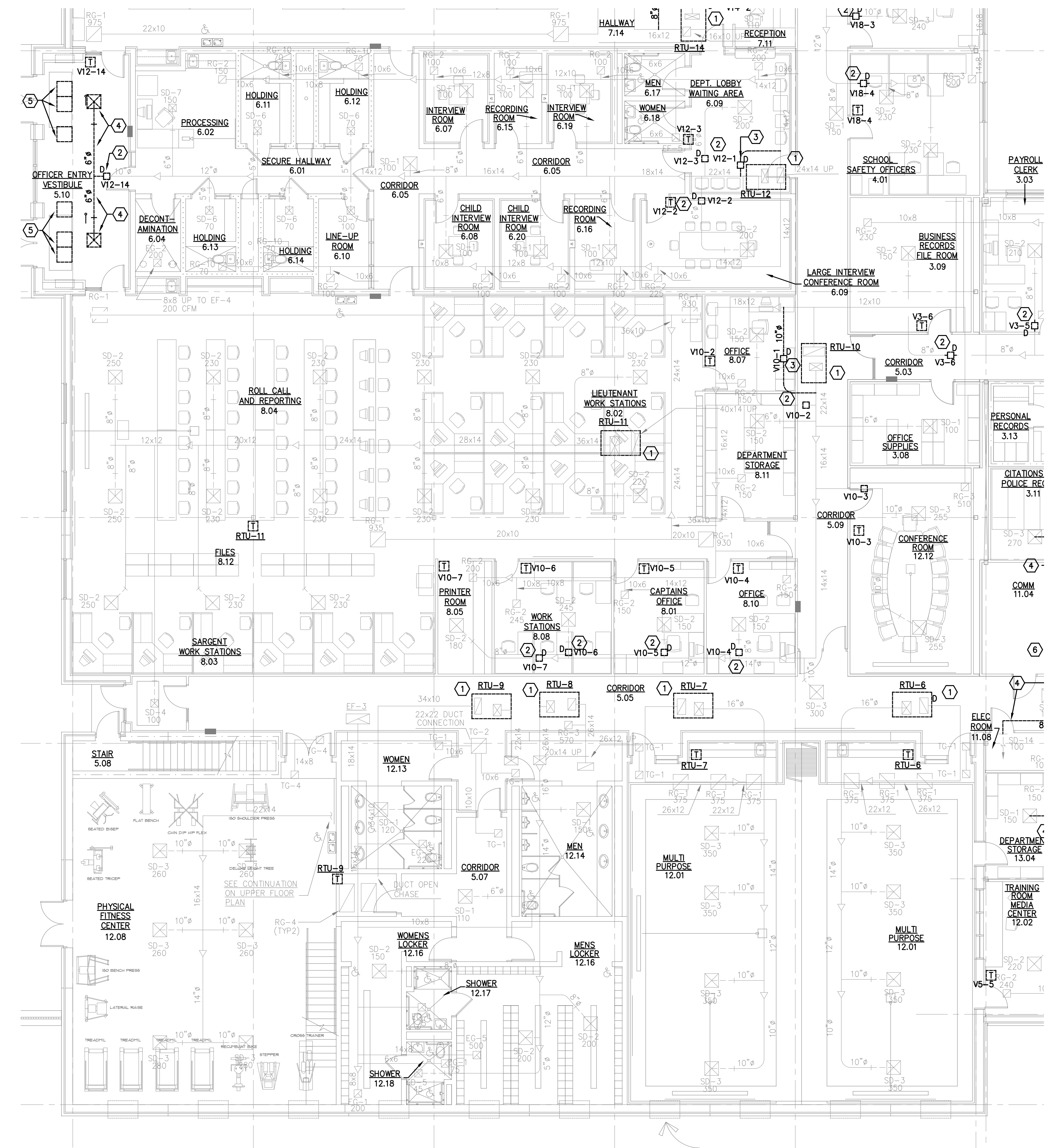
REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
 3000 CONRAD LANE
 BURLINGTON, KY 41005

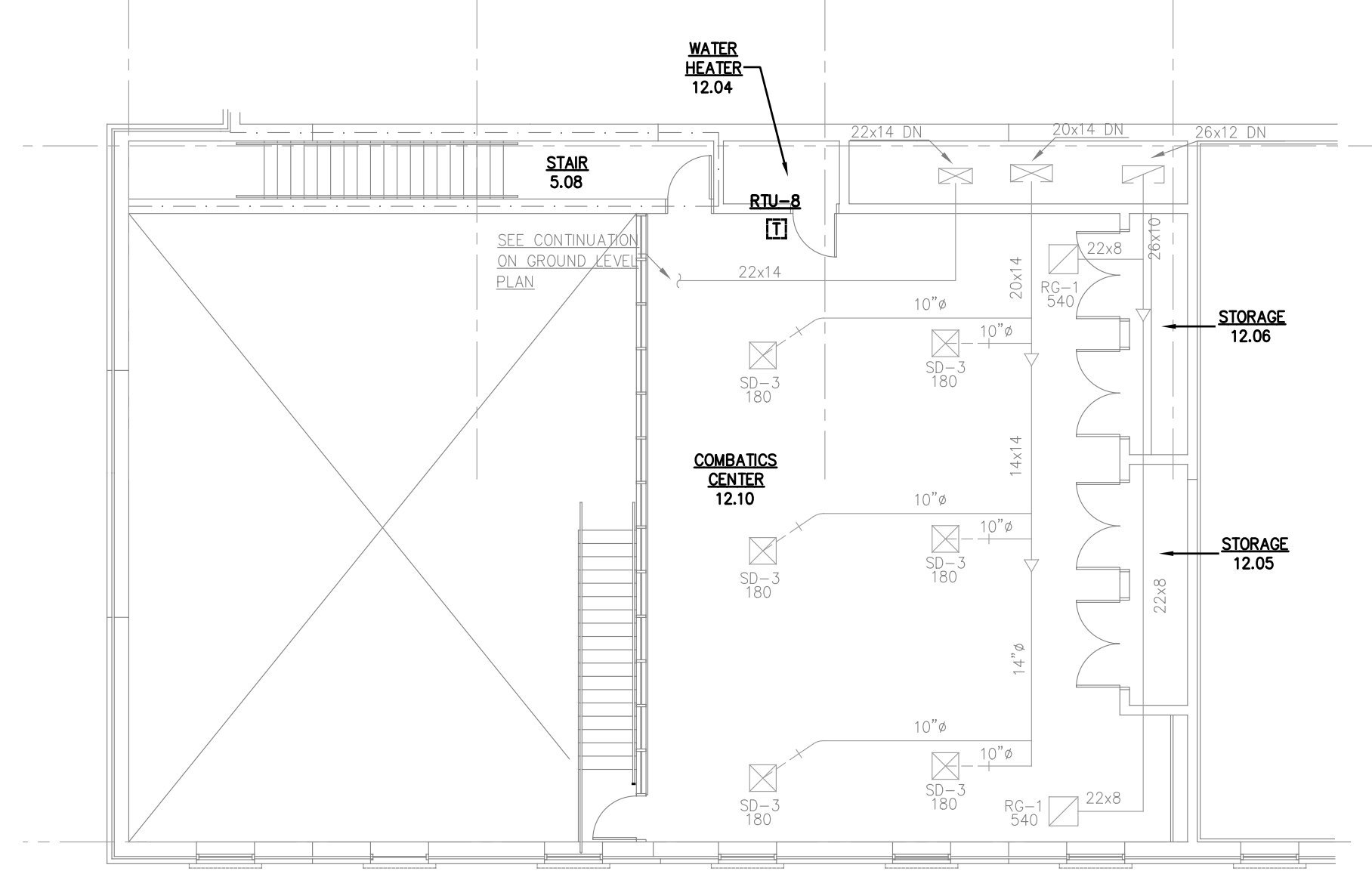
SHEET TITLE: **AREA 2 - HVAC DEMOLITION PLAN**

DRN:	CHK:	CAD REF:
SMG	SMG	14618M-1
DATE:	JOB NO.	
07-05-19	14618	
SHEET No.:	M-1.1	

ISSUED FOR BIDDING

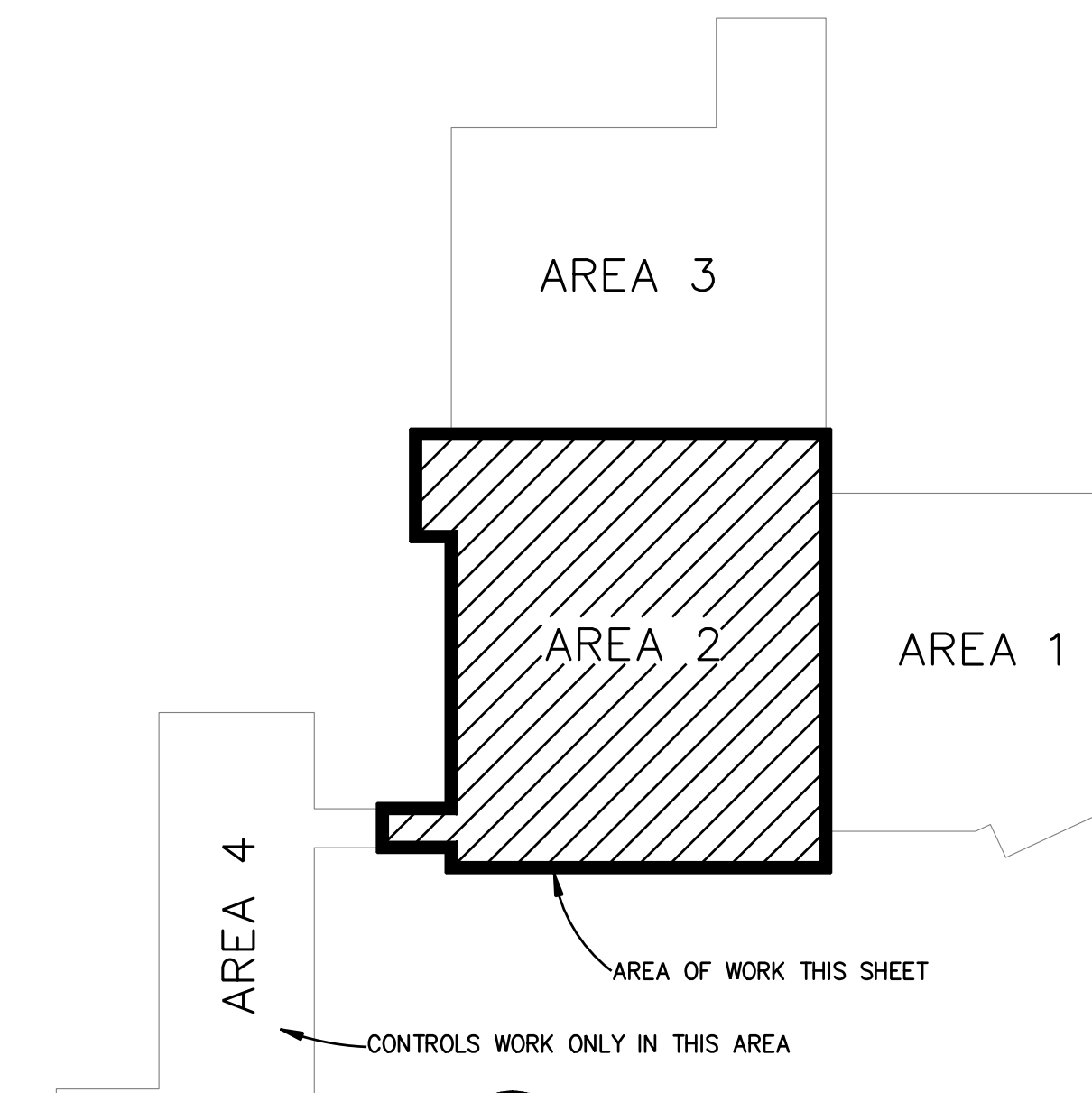


AREA 2 - HVAC DEMOLITION PLAN
 SCALE: 1/8" = 1'-0"



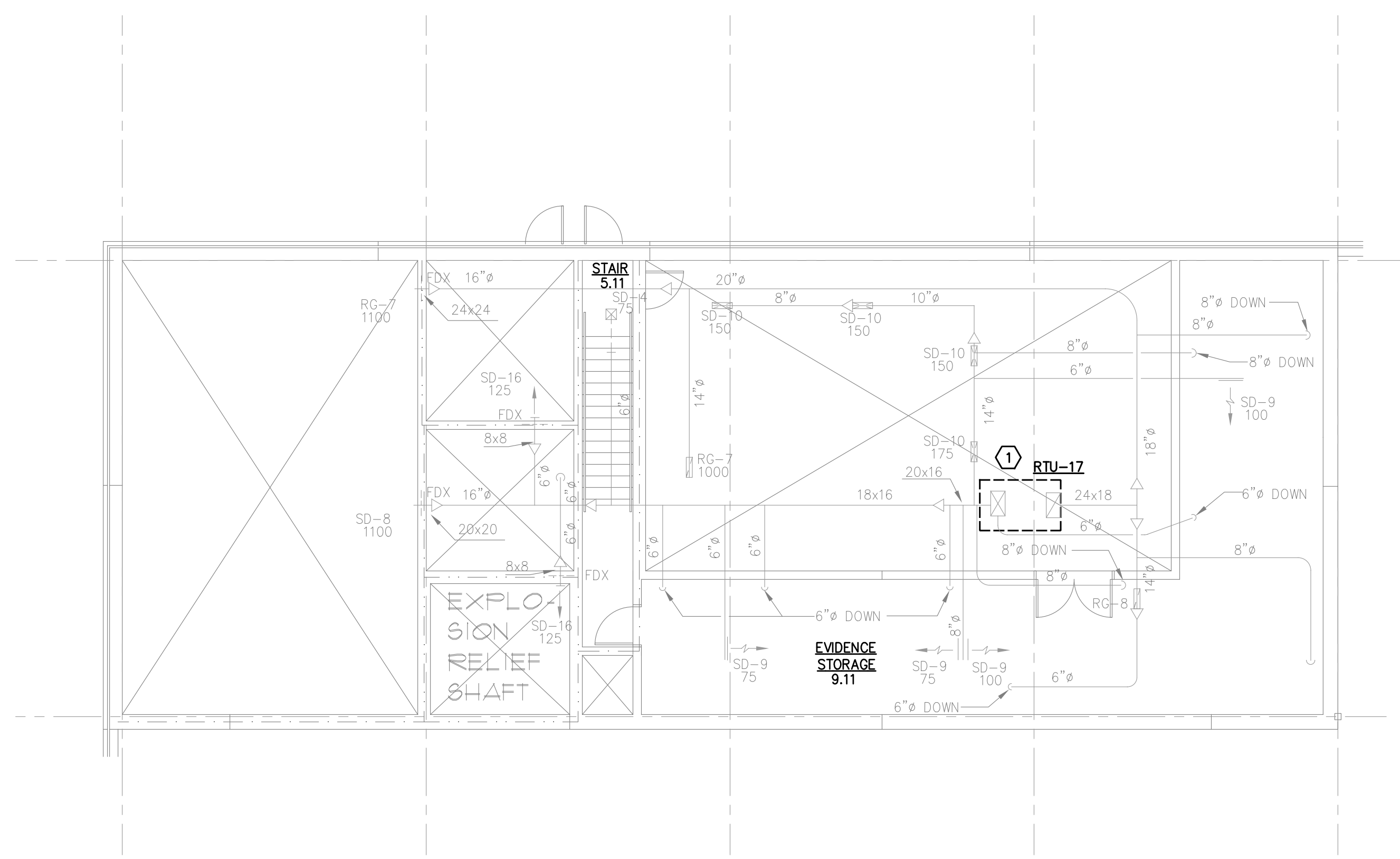
AREA 2 UPPER LEVEL - HVAC DEMOLITION PLAN
 SCALE: 1/8" = 1'-0"

- HVAC DEMO NOTES - SHEET M-1.1 ONLY
- EXISTING ROOFTOP UNIT AND ISOLATION RAIL TO BE REMOVED.
 - EXISTING VVT TERMINAL AND CONTROLS TO BE REMOVED.
 - EXISTING VVT BYPASS TERMINAL AND DUCTWORK TO BE REMOVED.
 - REMOVE THE AIR DEVICES AND DUCTWORK AS SHOWN.
 - REMOVE THE ELECTRIC CEILING RADIATION PANELS.



KEY PLAN
 SCALE: NONE

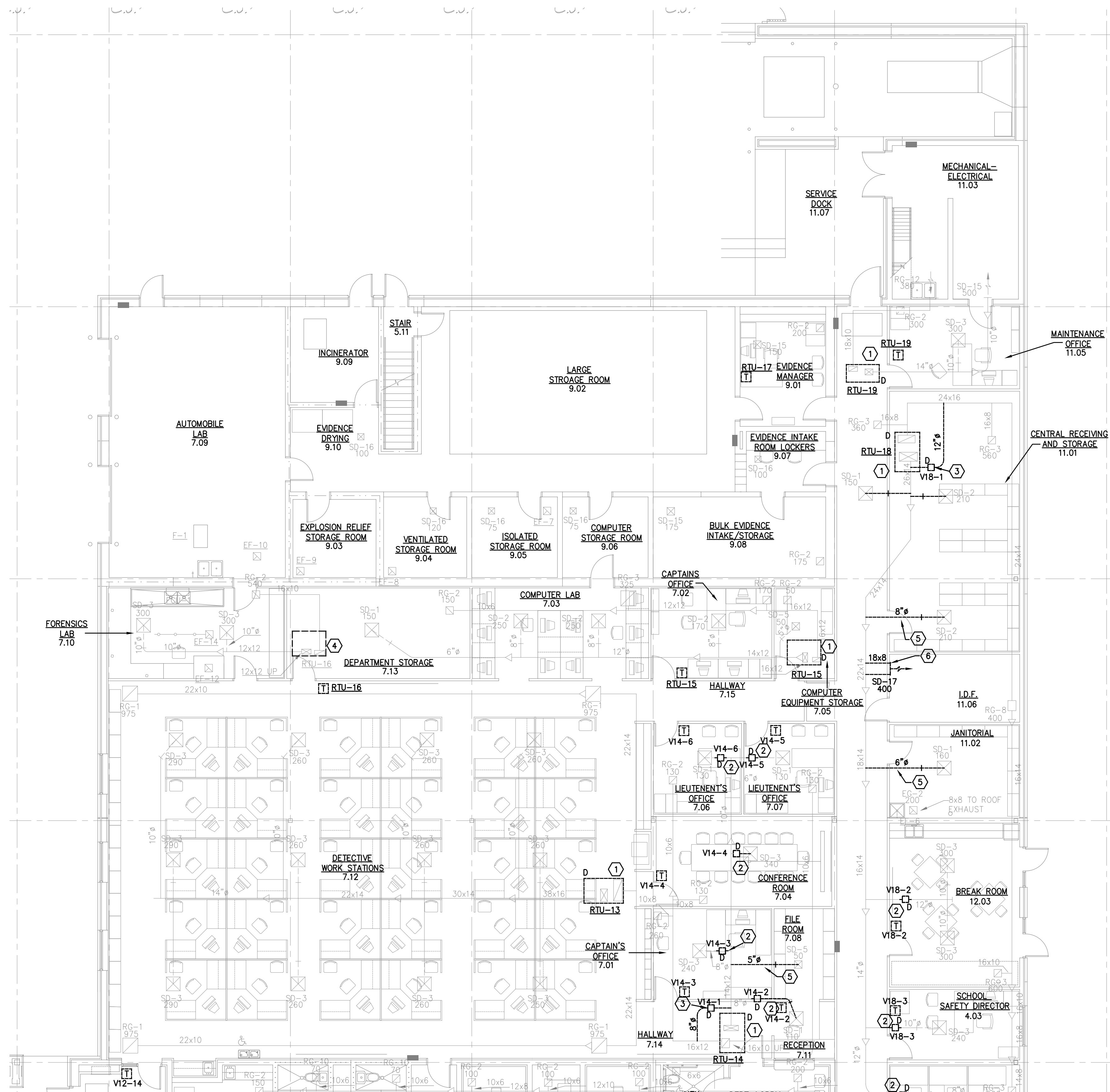
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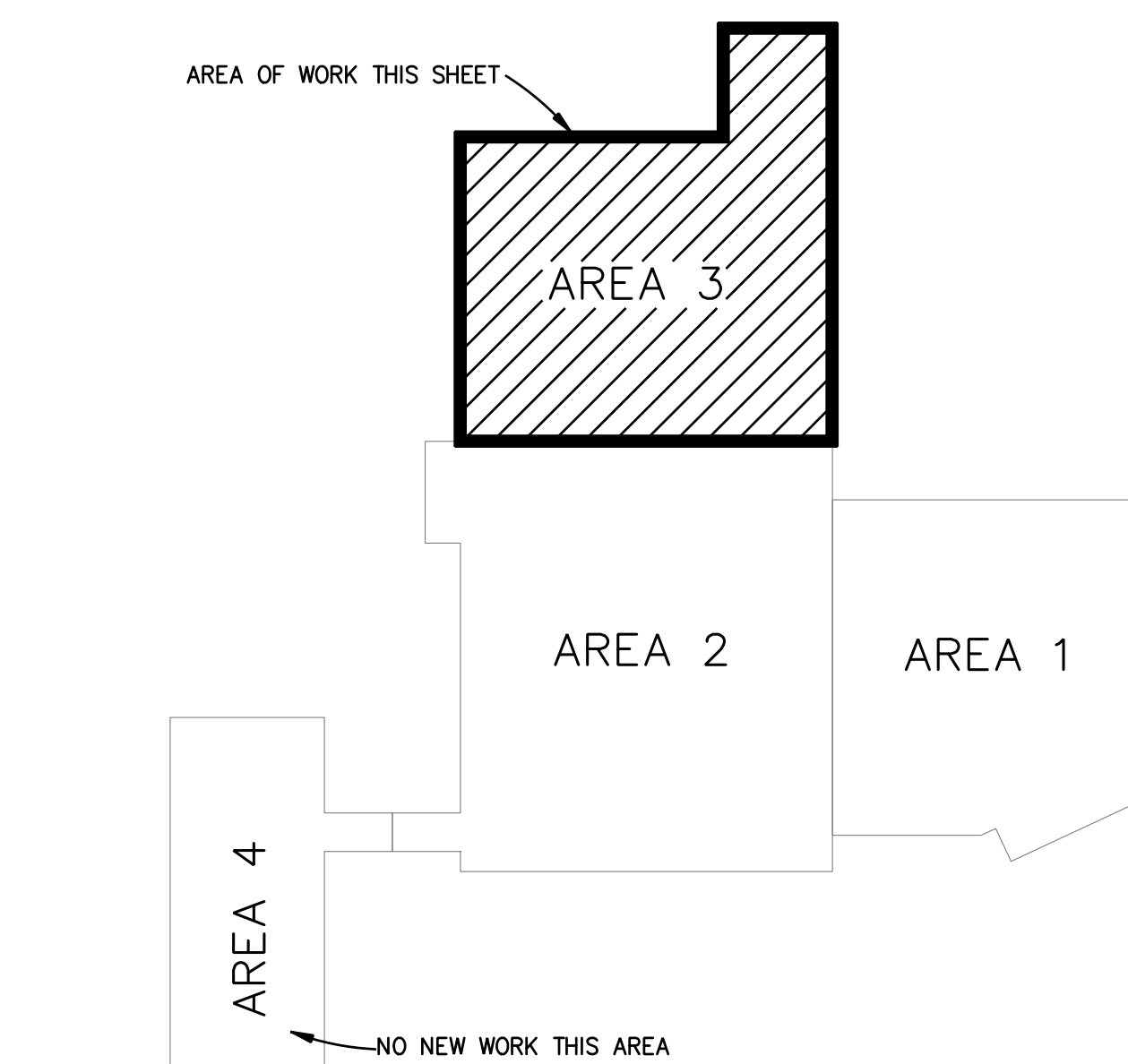
AREA 3 UPPER LEVEL - HVAC DEMOLITION PLAN
SCALE: 1/8" = 1'-0"

○ HVAC DEMO NOTES - SHEET M-12 ONLY

1. EXISTING ROOFTOP UNIT AND ISOLATION RAIL TO BE REMOVED.
2. EXISTING VVT TERMINAL AND CONTROLS TO BE REMOVED.
3. EXISTING VVT BYPASS TERMINAL TO BE REMOVED.
4. EXISTING RTU TO BE REMOVED WITH CURB ABANDONED IN PLACE. SEE NOTE 2 ON SHEET M-2.3 AND NOTE 5 ON SHEET M-2.2.
5. REMOVE THE EXISTING DUCT AS SHOWN.
6. REMOVE THE EXISTING REGISTER AND DUCT.



AREA 3 - HVAC DEMOLITION PLAN
SCALE: 1/8" = 1'-0"

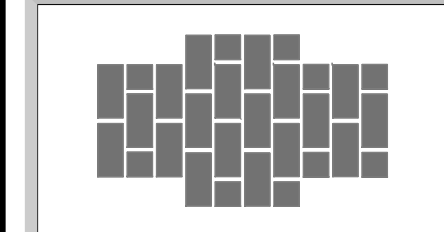


KEY PLAN
SCALE: NONE

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REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**

BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

DRN: SMG

CHK: SMG
CAD REF: 14618M-1

DATE: 07-05-19

JOB NO. 14618

SHEET No.:

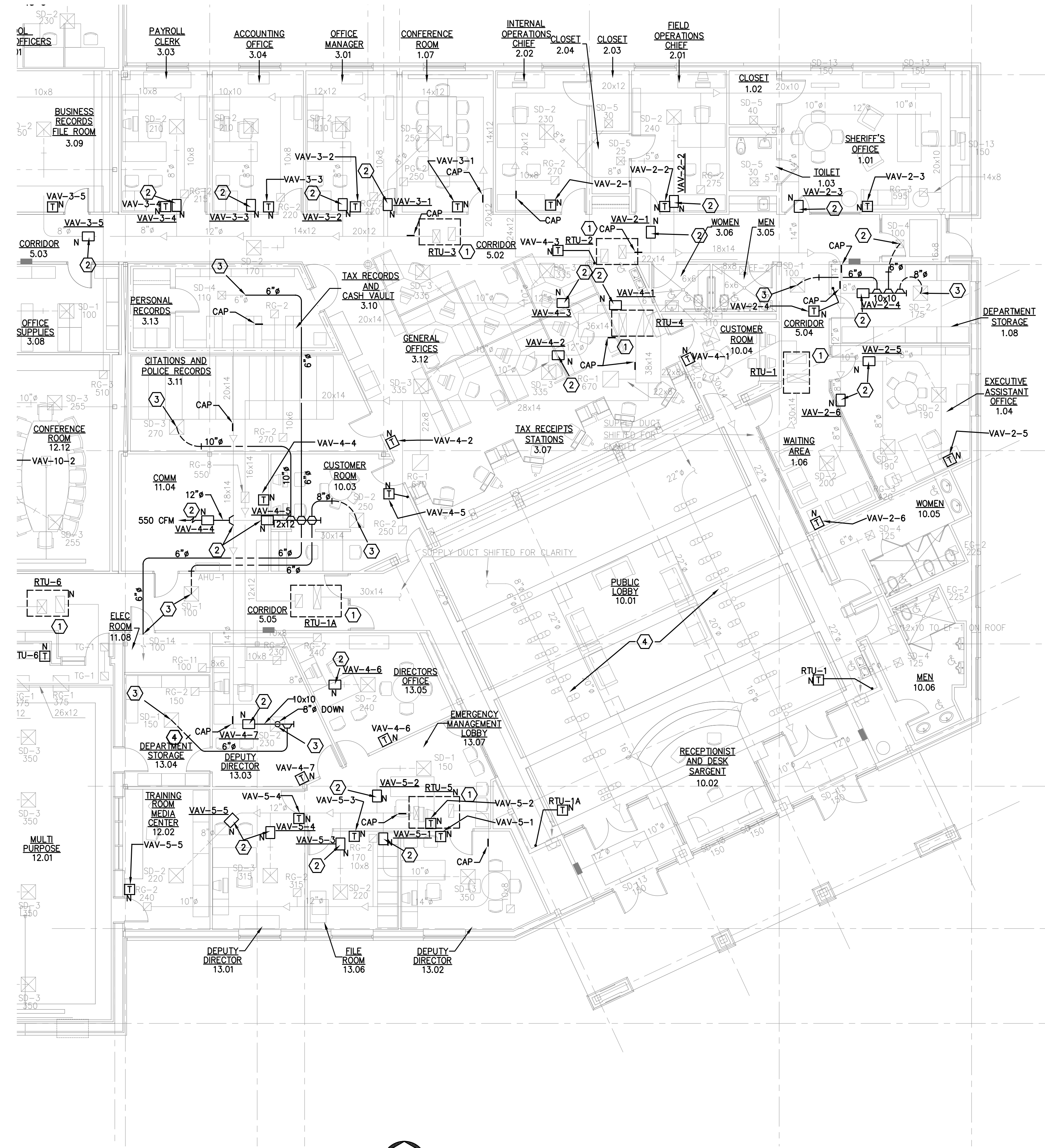
M-1.2

SHEET TITLE: **AREA 3 - HVAC DEMOLITION PLAN**

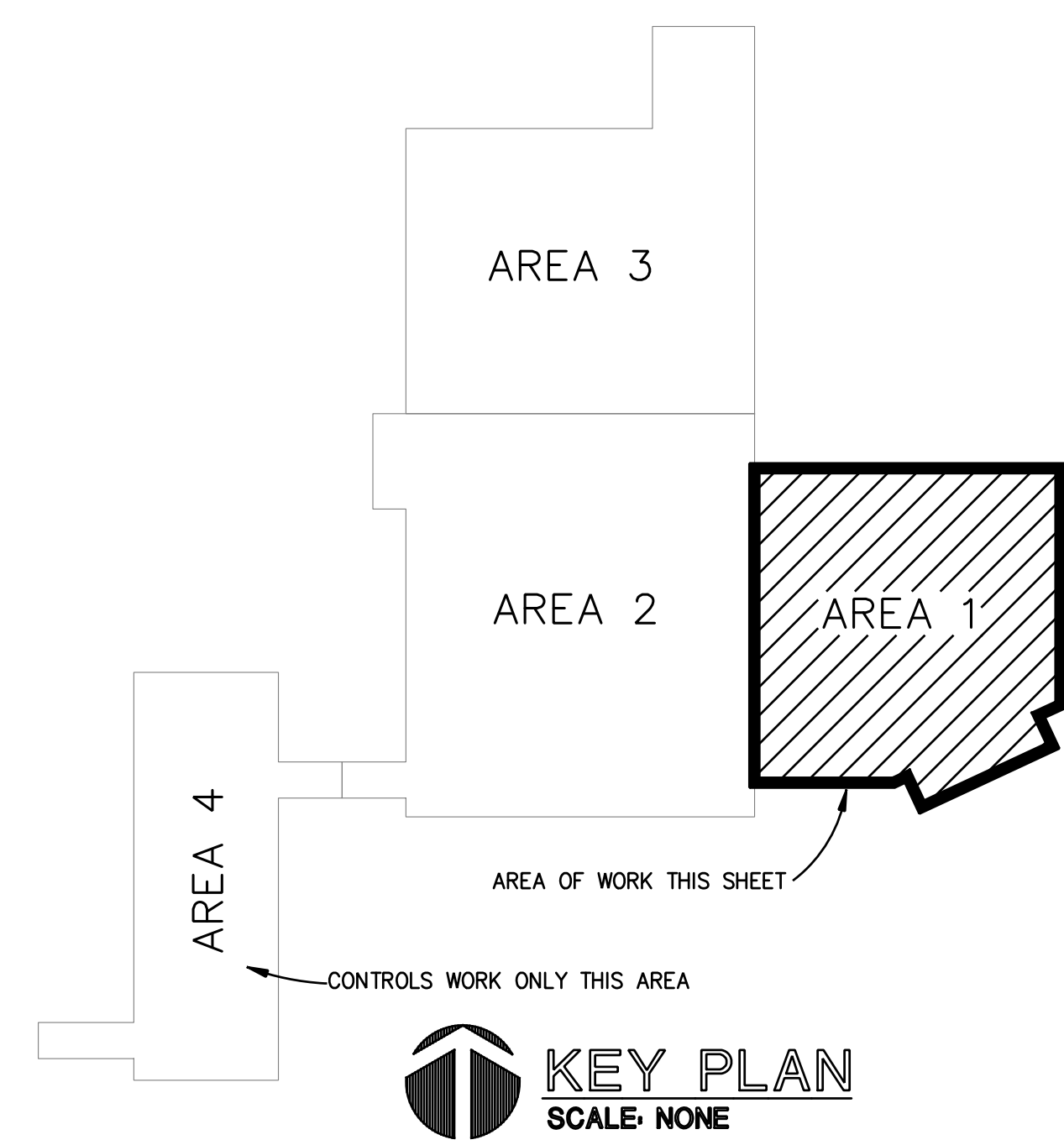
ISSUED FOR BIDDING

HVAC CONSTRUCTION NOTES - SHEET M-2.0 ONLY

1. NEW ROOFTOP UNIT SET ON THE EXISTING CURB WITH A CURB ADAPTOR.
2. PROVIDE NEW VAV BOX AND CONNECT TO EXISTING DUCTWORK AS SHOWN.
3. CONNECT TO THE EXISTING AIR DEVICE.
4. BLANK-OFF EVERY OTHER ONE OF THE EXISTING LOBBY LINEAR DIFFUSERS SO THAT NO AIR IS SUPPLIED. REINSTALL THE LINEAR DIFFUSERS SO THERE IS NO CHANGE IN APPEARANCE. A TOTAL OF EIGHT LINEAR DIFFUSERS SHALL BE NON-FUNCTIONAL.



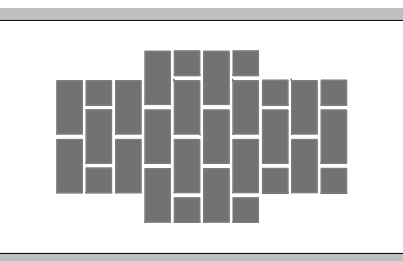
AREA 1 - HVAC FLOOR PLAN
SCALE: 1/8" = 1'-0"



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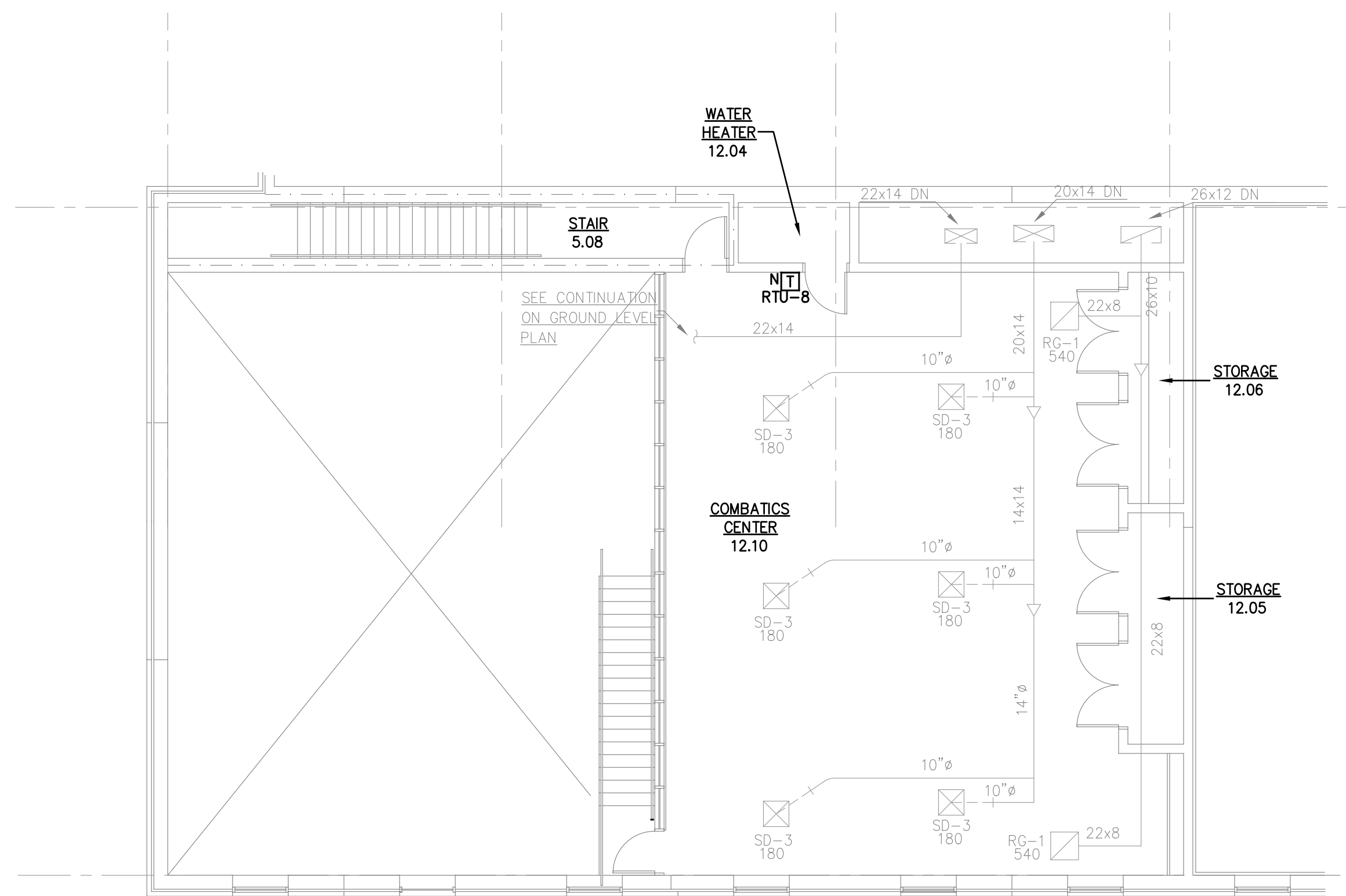
REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE: **AREA 1 - HVAC FLOOR PLAN**

DRN:	CHK:	CAD REF:
SMG	SMG	14618M-1
DATE:	JOB NO.	
07-05-19	14618	
SHEET No.:		
M-2.0		

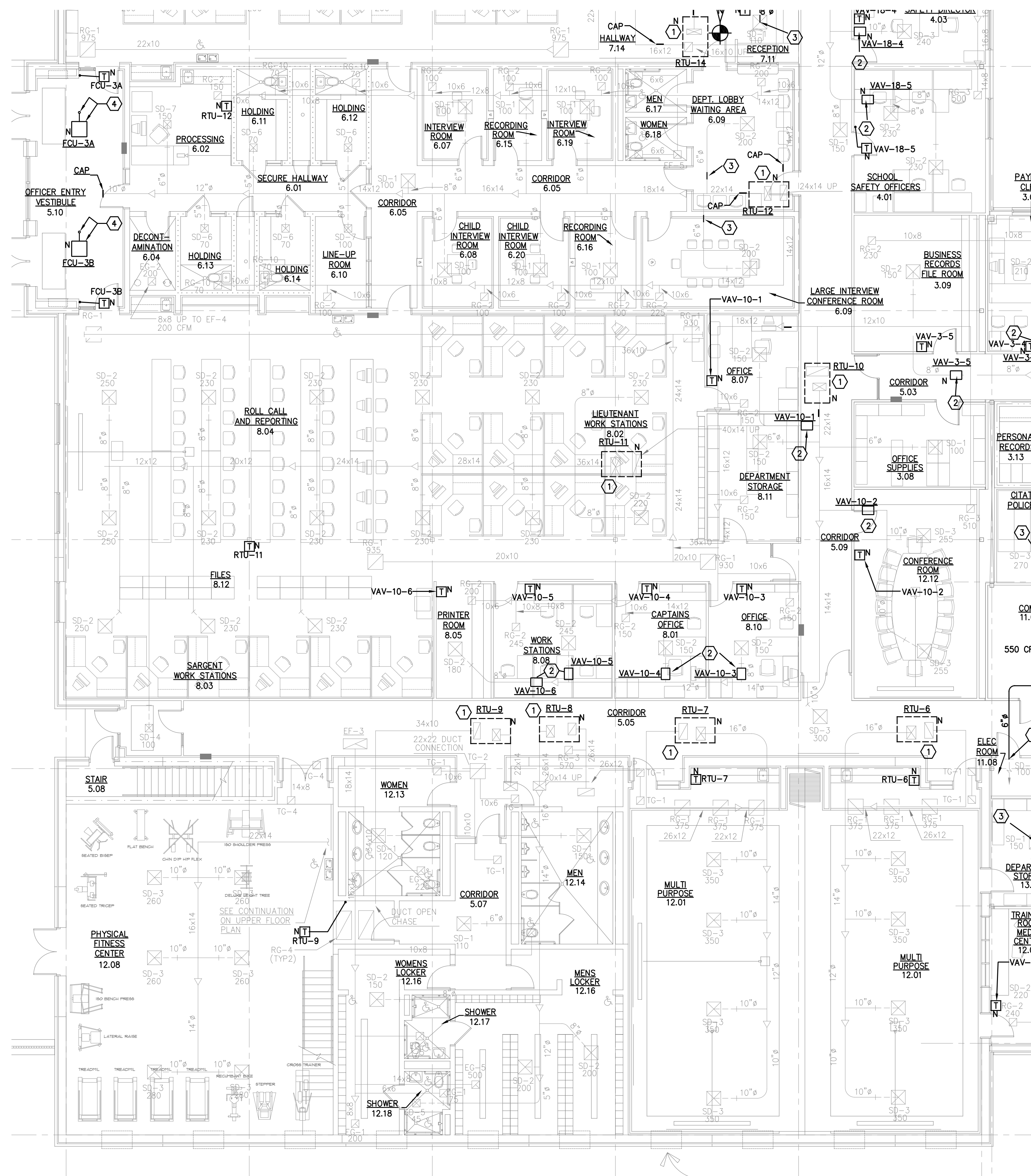
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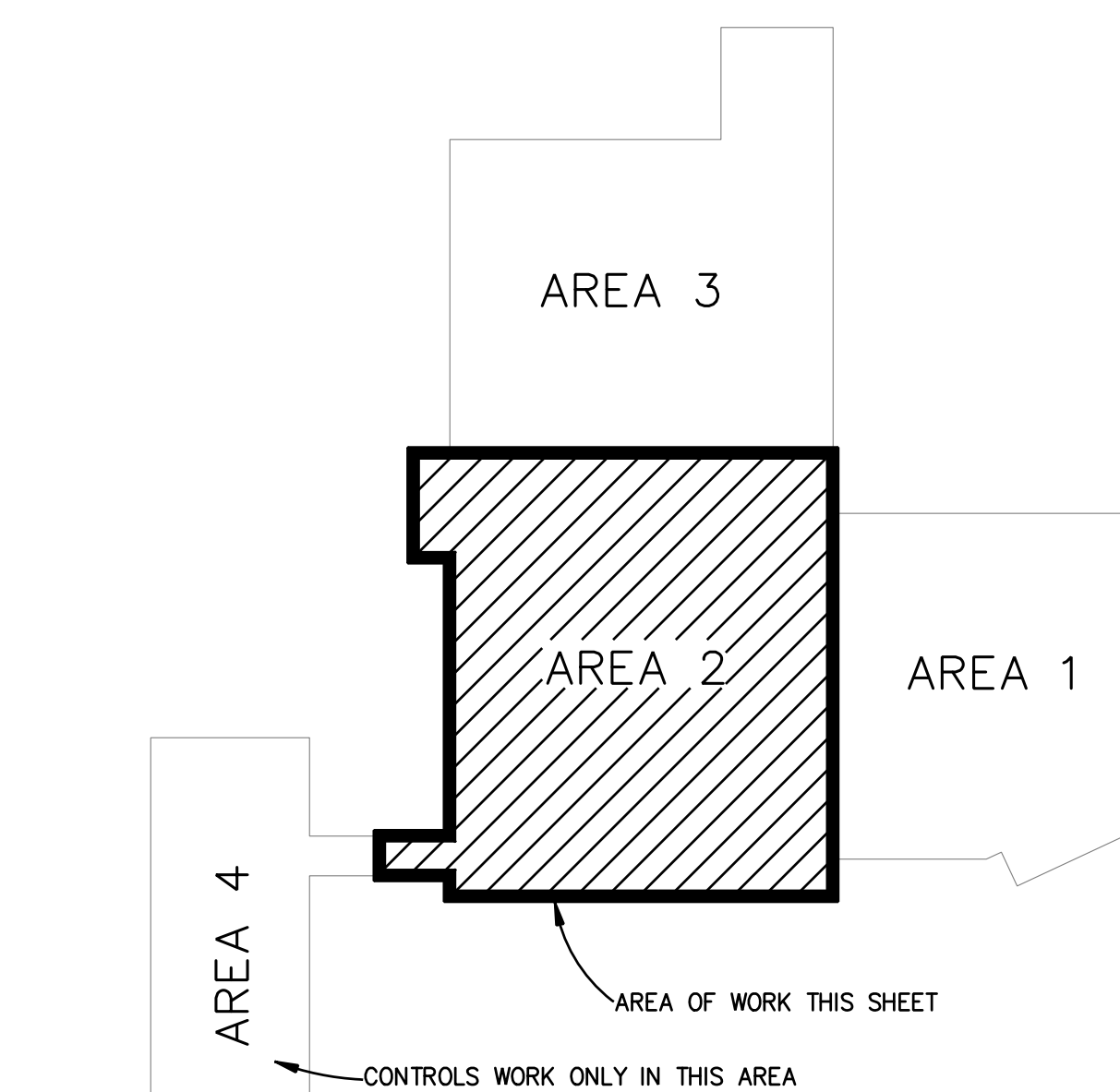
AREA 2 UPPER LEVEL - HVAC FLOOR PLAN
SCALE: 1/8" = 1'-0"

HVAC CONSTRUCTION NOTES - SHEET M-2.1 ONLY

1. NEW ROOFTOP UNIT SET ON THE EXISTING CURB WITH A CURB ADAPTOR.
2. PROVIDE NEW VAV BOX AND CONNECT TO EXISTING DUCTWORK AS SHOWN.
3. REPAIR DUCTWORK FROM DEMOLISHED VVT BOXES.
4. NEW CASSETTE FAN COIL UNITS MOUNTED IN THE EXISTING DROP CEILING AND COUPLED WITH HP-3. PUMP CONDENSATE UP TO ROOF AND DISCHARGE AT SPLASH BLOCK.



AREA 2 - HVAC FLOOR PLAN
SCALE: 1/8" = 1'-0"

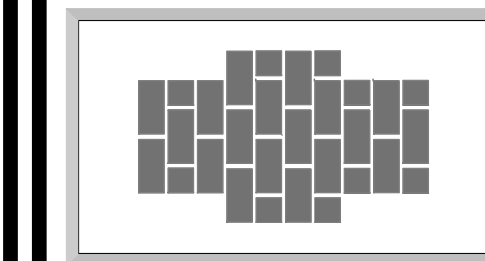


KEY PLAN
SCALE: NONE

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BOONE COUNTY PUBLIC SAFETY CAMPUS
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE:
AREA 2 - HVAC FLOOR PLAN

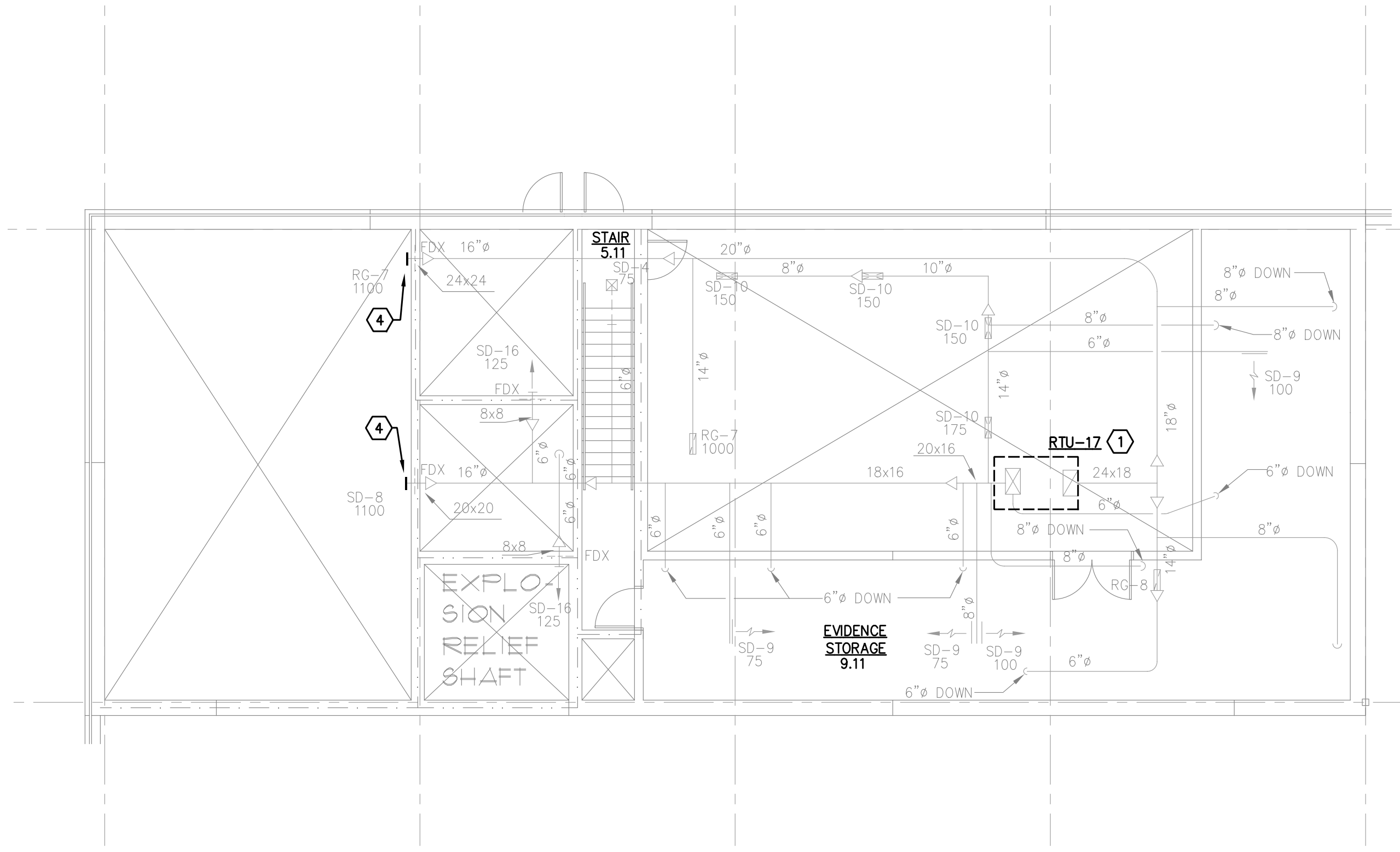
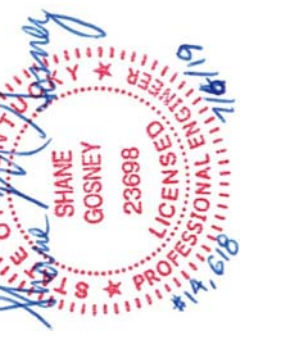
DRN: SMG
CHK: SMG
CAD REF: 14618M-1

DATE: 07-05-19
JOB NO.: 14618

SHEET No.:

M-2.1

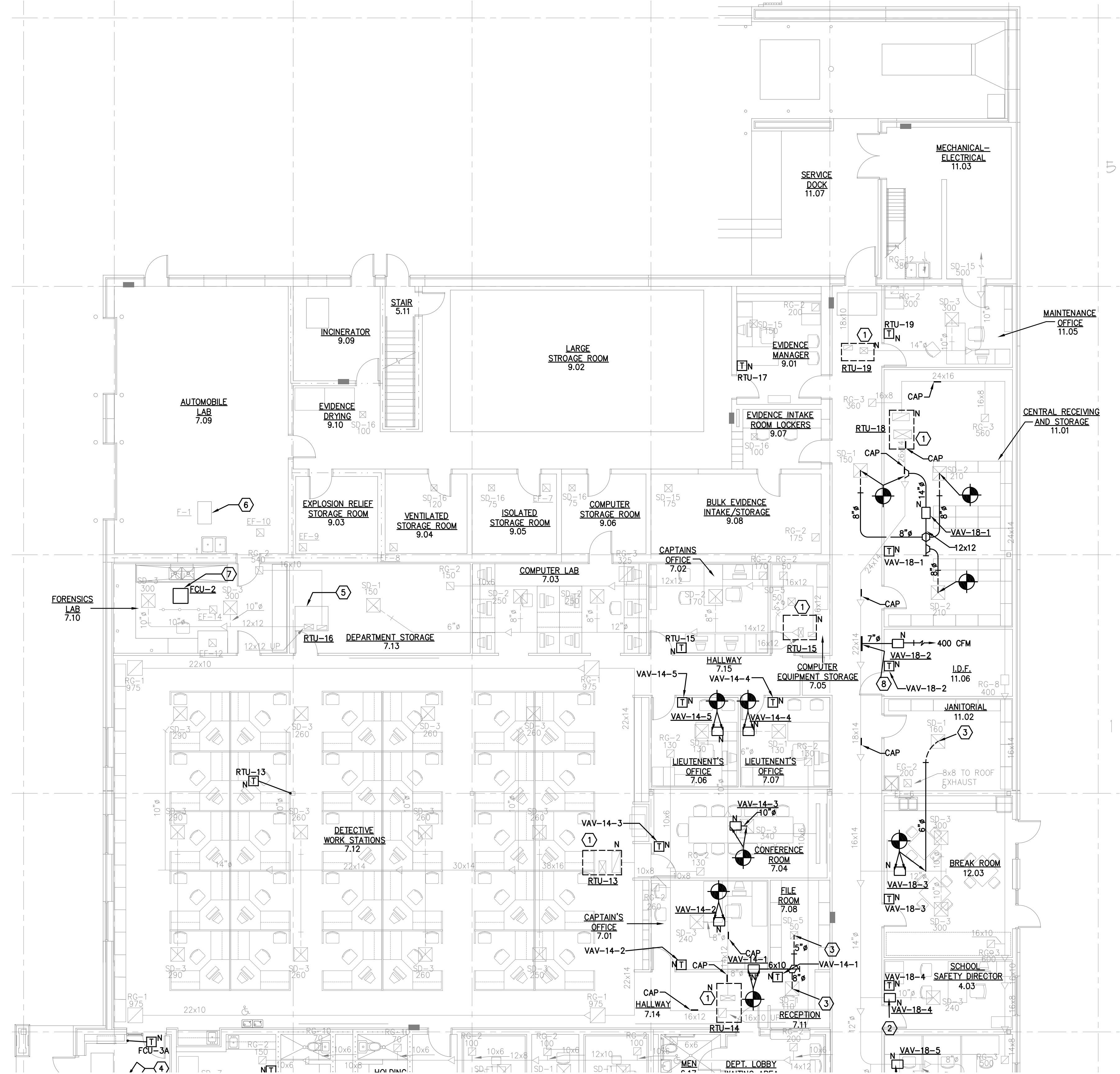
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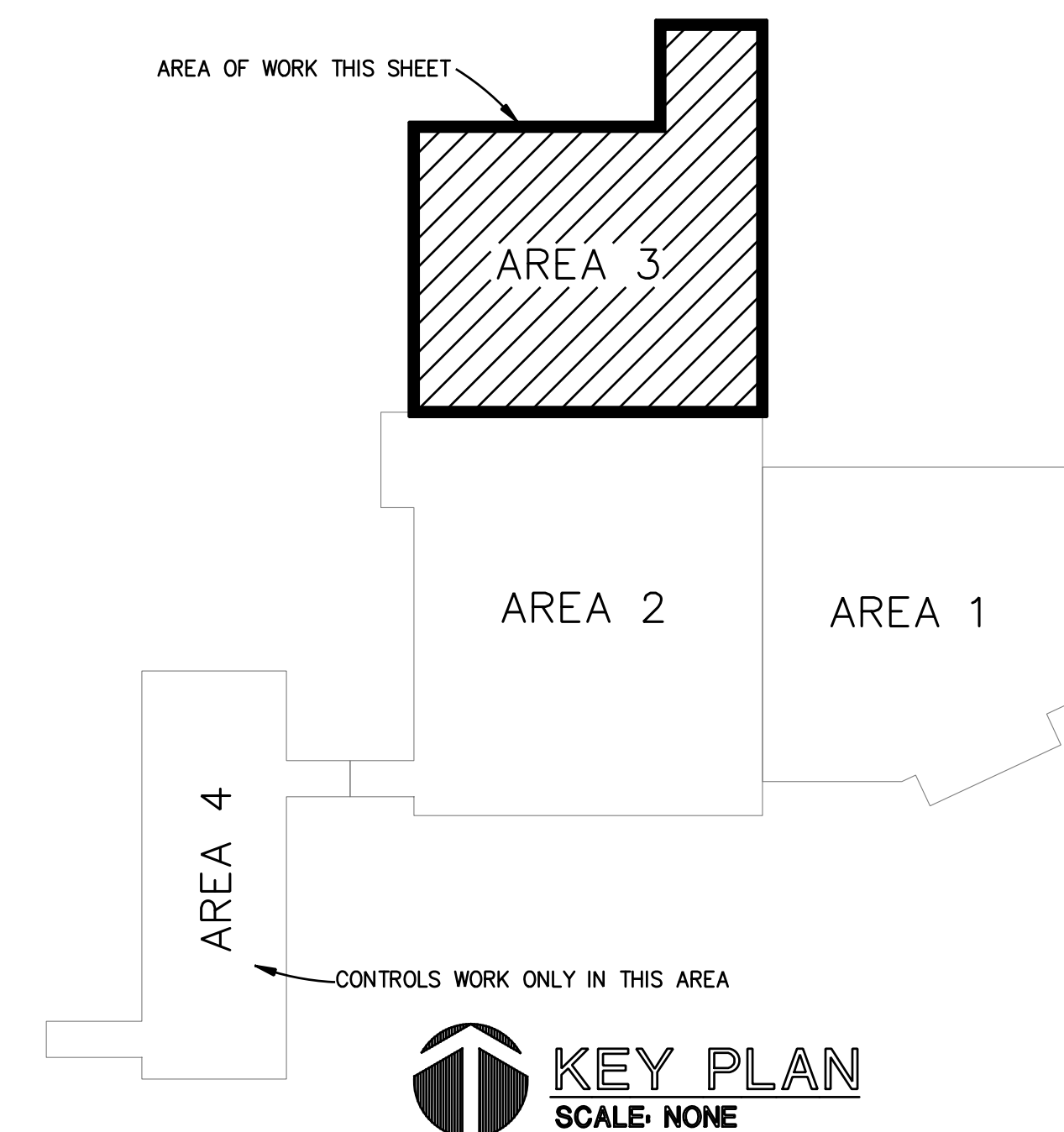
AREA 3 UPPER LEVEL - HVAC FLOOR PLAN
SCALE: 1/8" = 1'-0"

○ HVAC CONSTRUCTION NOTES - SHEET M-2.2 ONLY

1. NEW ROOFTOP UNIT SET ON THE EXISTING CURB WITH A CURB ADAPTOR.
2. PROVIDE NEW VAV BOX AND CONNECT TO EXISTING DUCTWORK AS SHOWN.
3. CONNECT TO THE EXISTING AIR DEVICE AS SHOWN.
4. BLANK-OFF THE EXISTING AIR DEVICES TO AUTOMOBILE LAB 7.09. REINSTALL AIR DEVICES.
5. RTU-18 SHALL NOT BE REPLACED. INSULATE AND CAP THE EXISTING CURB.
6. THE EXISTING FURNACE AND CONDENSING UNIT SHALL SERVE AUTOMOBILE LAB 7.09.
7. PROVIDE A REDUNDANT SYSTEM (FCU-2/HP-2) TO THE EXISTING FCU-1/HP-1 DUCTLESS SPLIT SYSTEM. ROUTE THE CONDENSATE THROUGH THE WALL TO THE EXISTING UTILITY SINK IN THE AUTOMOBILE LAB.
8. INSTALL A SHEETMETAL CAP OVER THE 18x8 DUCT OPENING FROM REMOVED BRANCH DUCT AND TAP OVER CAPPED OPENING WITH A NEW 7" TO NEW VAV BOX.

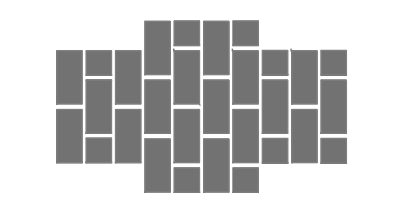


AREA 3 - HVAC FLOOR PLAN
SCALE: 1/8" = 1'-0"



KEY PLAN
SCALE: NONE

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ENGINEERING SERVICES, INC.
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NEWPORT, KY 41071
859.431.6083
halpe.com



REVISIONS:

PROJECT: BOONE COUNTY PUBLIC SAFETY CAMPUS
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE: AREA 3 - HVAC FLOOR PLAN

DRN:	CHK:	CAD REF:
SMG	SMG	14618M-1
DATE:	JOB NO.	
07-05-19	14618	
SHEET No.:		
M-2.2		

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○ HVAC CONSTRUCTION NOTES - SHEET M-2.3 ONLY

1. NEW ROOFTOP UNIT SET ON THE EXISTING CURB WITH A CURB ADAPTOR.
2. REMOVE THE EXISTING ROOFTOP UNIT. INSULATE AND CAP THE CURB. CAP THE EXISTING GAS PIPING.
3. NEW HEAT PUMP TO SERVE AS A REDUNDANT SYSTEM IN THE FORENSICS LAB 7.10.

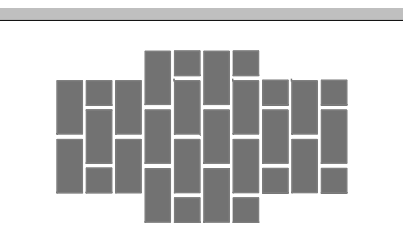


HVAC ROOF PLAN
SCALE: 1/16" = 1'-0"

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PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE: **HVAC ROOF PLAN**

DRN: SMG	CHK: SMG	CAD REF: 14618M-1
DATE: 07-05-19	JOB NO. 14618	
SHEET No.: M-2.3		

ISSUED FOR BIDDING



MARK	EXISTING ROOFTOP UNIT		NEW ROOFTOP UNIT				COOLING (MBH)		SUPPLY (CFM)	OUTSIDE AIR (CFM)	EXT. S.P. (IN WC)	HEATING (NAT. GAS)		EVAPORATOR FAN ELECTRIC				COMPRESSOR/CONDENSER FAN ELECTRIC				WEIGHT (LBS.)	NOTES	
	NOM. TONS	AAON MODEL	NOM. TONS	AAON MODEL (OR EQUAL)	SYSTEM TYPE	TOTAL	SENSIBLE	INPUT (MBH)				OUTPUT (MBH)	FLA	MCA	MOC	VOLTS	PHASE	FLA	MCA	MOC	VOLTS			PHASE
RTU-1	8.0	RK-08-2-EO-212	3.0	RQ-003-8-V-EA09-312	CAV	39.8	31.09	1200	240	1	60	48.6	6	7	15	208	3	15	17	25	208	3	834	1 TO 9
RTU-1A	8.0	RK-08-2-EO-212	3.0	RQ-003-8-V-EA09-312	CAV	39.8	31.09	1200	240	1	60	48.6	6	7	15	208	3	15	17	25	208	3	834	1 TO 9
RTU-2	6.0	RK-06-2-EO-232	5.0	RQ-005-8-V-EB09-339	VAV	65.15	52.52	2000	400	1.5	100	81	9	11	15	208	3	20	24	40	208	3	973	1 TO 10
RTU-3	3.0	RK-03-2-EO-212	3.0	RQ-003-8-V-EA09-339	VAV	40.11	32.51	1200	200	1.5	100	81	13	15	20	208	3	15	17	25	208	3	895	1 TO 9
RTU-4	8.0	RK-08-2-FO-222	8.0	RN-008	VAV	94.36	78.11	3200	780	1	150	120	22	25	35	208	3	31	37	60	208	3	1307	1 TO 10
RTU-5	3.0	RK-03-2-EO-212	3.0	RQ-003-8-V-EA09-339	VAV	39.84	31.75	1255	200	1.5	100	81	6	7	15	208	3	15	17	25	208	3	849	1 TO 9
RTU-6	4.0	RK-04-2-EO-222	4.0	RQ-004-8-V-GA02-332	SINGLE ZONE VAV	48.79	37.73	1400	280	1	100	81	6	7	15	208	3	19	23	35	208	3	935	1 TO 9
RTU-7	4.0	RK-04-2-EO-222	4.0	RQ-004-8-V-GA02-332	SINGLE ZONE VAV	48.79	37.73	1400	280	1	100	81	8	10	15	208	3	19	23	35	208	3	935	1 TO 9
RTU-8	6.0	RK-06-2-FO-232	5.0	RQ-005-8-V-EA09-332	CAV	62.37	50.25	2000	500	1.5	100	81	9	11	15	208	3	20	24	40	208	3	979	1 TO 10
RTU-9	6.0	RK-06-2-EO-232	4.0	RQ-004-8-V-EB09-332	CAV	53.45	42.91	1600	400	1.5	100	81	9	11	15	208	3	19	23	35	208	3	999	1 TO 9
RTU-10	5.0	RK-05-2-FO-232	5.0	RQ-005-8-V-EB09-359	VAV	64.69	51.47	1935	380	1.5	140	113.4	9	11	15	208	3	20	24	40	208	3	987	1 TO 10
RTU-11	10.0	RK-10-2-FO-222	9.0	RN-009	SINGLE ZONE VAV	97.4	79.16	3600	770	1	195	156	16	19	25	208	3	35	39	50	208	3	1848	1 TO 10
RTU-12	6.0	RK-06-2-EO-232	5.0	RQ-005-8-V-EA09-332	CAV	62.37	50.25	2000	500	1.5	100	81	8	10	15	208	3	20	24	40	208	3	979	1 TO 10
RTU-13	10.0	RK-10-2-FO-222	8.0	RN-008	SINGLE ZONE VAV	94.36	78.11	3200	780	1	150	120	19	21	30	208	3	31	37	60	208	3	1307	1 TO 10
RTU-14	3.0	RK-03-2-EO-212	3.0	RQ-003-8-V-EA09-339	VAV	38.76	28.64	1000	200	1.5	100	81	6	7	15	208	3	15	17	25	208	3	849	1 TO 9
RTU-15	2.0	RK-02-1-EO-212	2.0	RQ-002-9-V-GA02-312	CAV	25.98	21.61	870	175	1.5	60	48.6	6	7	15	208	1	15	17	25	208	1	839	1 TO 9
RTU-16	2.0	RK-02-1-EO-312	--	--	--	--	--	--	--	--	--	--	6	7	15	--	--	15	17	25	--	--	--	UNIT TO BE REMOVED AND NOT REPLACED
RTU-17	8.0	RK-08-2-FO-212	5.0	RQ-005-8-V-EA09-332	CAV	62.37	50.25	1920	300	1	100	81	9	11	15	208	3	20	24	40	208	3	979	1 TO 10
RTU-18	6.0	RK-06-2-FO-232	6.0	RN-006-8-O-EB09-319	VAV	69.86	65.74	2430	560	1.5	210	168	8	10	15	208	3	20	24	40	208	3	1215	1 TO 10
RTU-19	2.0	RK-02-1-EO-212	2.0	RQ-002-9-V-GA02-312	CAV	25.59	21.38	800	120	1	60	48.6	6	7	15	208	1	15	17	25	208	1	870	1 TO 9

- NOTES:
- DIFFERENTIAL ENTHALPY ECONOMIZER WITH BAROMETRIC RELIEF.
 - HOT GAS REHEAT.
 - DUAL POWER FEED: EVAPORATOR FAN AND FLUE FANS ON EMERGENCY POWER; COMPRESSORS AND CONDENSER FANS ON NORMAL POWER. MANUFACTURER PROVIDED DISCONNECTS.
 - ROOF CURB ADAPTOR WITH SOUND INSULATION.
 - 7-DAY DIGITAL PROGRAMMABLE HEATING/COOLING THERMOSTAT.
 - FACTORY SUPPLIED CONVENIENCE OUTLET TO BE POWERED BY ELECTRICIAN.
 - EXTEND GAS PIPING TO RTU AS REQUIRED. PAINT ANY NEW PIPING YELLOW. REPLACE THE GAS PRESSURE REGULATOR AT EACH UNIT.
 - DIGITAL SCROLL MODULATING COMPRESSOR.
 - FACTORY MOUNTED CONTROL SYSTEM.
 - SMOKE DETECTOR (RATED FOR USE IN HVAC DUCTWORK) SHALL BE FACTORY INSTALLED BY THE MANUFACTURER. UPON ACTIVATION, THE SMOKE DETECTOR SHALL SHUT DOWN THE ENTIRE AIR DISTRIBUTION SYSTEM. SYSTEM SUPERVISION CONTROL SHALL BE IN ACCORDANCE WITH SECTION 608.4.1, IMC.

VARIABLE AIR VOLUME (VAV) BOX SCHEDULE

MARK	BOX # & LOCATION	PRICE MODEL (OR EQUAL)	MAXIMUM CFM	MINIMUM CFM	INLET SIZE	HEATING STAGES	HEATING COIL INPUT (KW)	HEATING COIL CAP (MBH)	DELTA T (F)	VOLTAGE	PHASE	NOTES
VAV-2-1	5.02	SDV	260	X	5"	SCR	2.0	6.8	20	208	1	1, 2, 3
VAV-2-2	5.01	SDV	265	X	5"	SCR	2.0	6.8	20	208	1	1, 2, 3
VAV-2-3	1.01	SDV	520	X	7"	SCR	4.0	13.6	20	208	1	1, 2, 3
VAV-2-4	1.08	SDV	375	X	6"	SCR	3.0	10.3	20	208	1	1, 2, 3
VAV-2-5	1.04	SDV	380	X	6"	SCR	2.5	8.5	20	208	1	1, 2, 3
VAV-2-6	1.06	SDV	200	X	4"	SCR	1.0	3.4	20	208	1	1, 2, 3
VAV-3-1	1.07	SDV	250	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-3-2	3.01	SDV	210	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-3-3	3.04	SDV	210	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-3-4	3.03	SDV	210	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-3-5	5.03	SDV	150	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-4-1	3.12	SDV	110	X	4"	SCR	0.5	1.7	20	208	1	1, 2, 3
VAV-4-2	3.12	SDV	670	X	8"	SCR	2.5	8.5	20	208	1	1, 2, 3
VAV-4-3	3.12	SDV	670	X	8"	SCR	3.0	10.3	20	208	1	1, 2, 3
VAV-4-4	11.04	SDV	550	X	12"	SCR	4.0	13.6	20	208	1	1, 2, 3
VAV-4-5	10.03	SDV	830	X	9"	SCR	4.0	13.6	20	208	1	1, 2, 3
VAV-4-6	13.05	SDV	240	X	5"	SCR	1.0	3.4	20	208	1	1, 2, 3
VAV-4-7	13.03	SDV	380	X	6"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-5-1	13.06	SDV	350	X	6"	SCR	2.5	8.5	20	208	1	1, 2, 3
VAV-5-2	13.07	SDV	150	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-5-3	13.06	SDV	220	X	5"	SCR	2.0	6.8	20	208	1	1, 2, 3
VAV-5-4	13.01	SDV	315	X	6"	SCR	2.0	6.8	20	208	1	1, 2, 3
VAV-5-5	13.01	SDV	220	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-10-1	5.09	SDV	150	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-10-2	12.12	SDV	510	X	7"	SCR	2.0	6.8	20	208	1	1, 2, 3
VAV-10-3	8.10	SDV	150	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-10-4	8.01	SDV	150	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-10-5	8.08	SDV	180	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-10-6	8.08	SDV	180	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-14-1	7.01	SDV	160	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-14-2	7.01	SDV	240	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-14-3	7.04	SDV	340	X	6"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-14-4	7.07	SDV	130	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-14-5	7.06	SDV	130	X	4"	SCR	0.75	2.5	20	208	1	1, 2, 3
VAV-18-1	11.01	SDV	420	X	7"	SCR	3.0	10.2	20	208	1	1, 2, 3
VAV-18-2	11.06	SDV	400	X	7"	SCR	2.5	8.5	20	208	1	1, 2, 3
VAV-18-3	12.03	SDV	760	X	9"	SCR	5.0	17.0	20	208	1	1, 2, 3
VAV-18-4	4.03	SDV	240	X	5"	SCR	1.5	5.1	20	208	1	1, 2, 3
VAV-18-5	4.01	SDV	460	X	7"	SCR	3.0	10.2	20	208	1	1, 2, 3

- NOTES:
- PRESSURE INDEPENDENT VAV BOX WITH ELECTRIC REHEAT AND DIGITAL CONTROLS.
 - SCR (SILICON CONTROL RECTIFIER) MODULATING CONTROL OF ELECTRIC HEAT WITH SOLID STATE CONTACTORS.
 - A DOOR INTERLOCK SWITCH SHALL BE PROVIDED TO CUT POWER TO THE ELECTRIC COIL PRIOR TO ACCESSING COMPONENTS IN THE CONTROL ENCLOSURE.

DUCTLESS SPLIT HEAT PUMP AIR HANDLING UNIT SCHEDULE (INDOOR UNIT)

MARK	CARRIER MODEL (OR EQUAL)	HEAT PUMP	AIRFLOW (CFM)		TOTAL		ELECTRIC				NOTES
			SUPPLY	O.A.	COOLING (MBH)	HEATING (MBH)	MCA	VOLTS	PHASE	MAX FUSE SIZE	
FCU-2	40MBC009-3	HP-2	290	---	9.0	10.9	---	208	1	---	2, 3, 4
FCU-3A	40MBCQ12-3	HP-3	320	---	11.5	10.0	---	208	1	---	2, 4, 5, 6
FCU-3B	40MBCQ12-3	HP-3	320	---	11.5	10.0	---	208	1	---	2, 4, 5, 6

- NOTES:
- NOT USED.
 - CEILING CASSETTE UNIT TO FIT IN A 2'x2' LAY-IN CEILING.
 - WALL MOUNTED HARD WIRED 7-DAY DIGITAL PROGRAMMABLE HEATING / COOLING THERMOSTAT.
 - POWER FEED FROM OUTDOOR UNIT.
 - BUILT-IN CONDENSATE LIFT PUMP.
 - REQUIRED VENTILATION AIR SUPPLIED THROUGH OPERABLE DOOR OPENINGS. VENTILATION AIR IS BASED ON SECTION 402 "NATURAL VENTILATION", IMC.

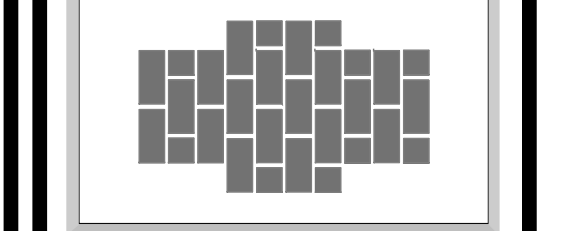
DUCTLESS SPLIT HEAT PUMP CONDENSING UNIT SCHEDULE (OUTDOOR UNIT)

MARK	CARRIER MODEL (OR EQUAL)	COOLING		HEATING*		ELECTRIC				WEIGHT (LBS.)	NOTES
		TOTAL (MBH)	SENSIBLE	TOTAL (MBH)	SENSIBLE	MCA	VOLTS	PHASE	MAX FUSE SIZE		
HP-2	38MAQB09-3	9.0	---	10.9	---	9	208	1	15	105.8	1, 2, 3, 4
HP-3	38MGR024C-3	23.0	---	20.0	---	25	208	1	35	149.9	1, 2, 3, 4, 5

- NOTES:
- LOCATED ON ROOF. VERIFY FINAL LOCATION.
 - REFRIGERANT PIPING AND ACCESSORIES AS RECOMMENDED BY MANUFACTURER.
 - MAINTAIN MANUFACTURER'S MINIMUM REQUIRED SERVICE AND AIRFLOW CLEARANCES.
 - POWER WIRING TO INDOOR UNIT(S).
 - HEAT PUMP SERVES INDOOR UNITS FCU-3A AND FCU-3B.
- * THE SCHEDULED HEATING CAPACITY SHALL BE THE MINIMUM CAPACITY AT 5 DEGREES F OUTSIDE AND 69 DEGREE ENT DB AT FAN COIL.

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HAL-PE ASSOCIATES
 ENGINEERING SERVICES, INC.
 530 W. 9TH ST.
 NEWPORT, KY 41071
 859.431.6083
 halpe.com



REVISIONS:

BOONE COUNTY PUBLIC SAFETY CAMPUS
BOONE COUNTY SHERIFF
 3000 CONRAD LANE
 BURLINGTON, KY 41005

PROJECT:

DRN: CHK: CAD REF:
 SMG SMG 14618M-1

DATE: JOB NO.
 07-05-19 14618

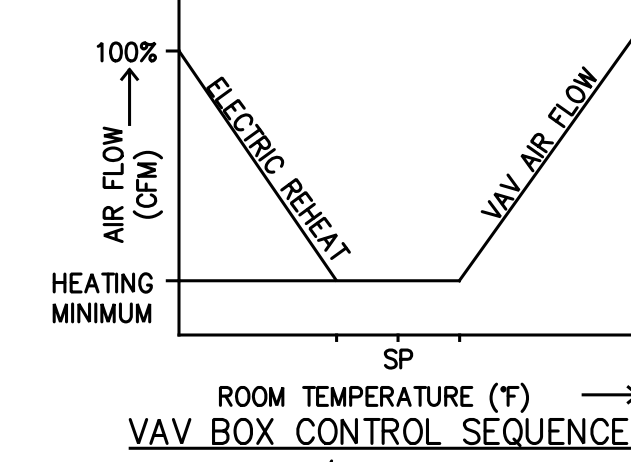


CONTROLS SYMBOLS

- (T) ROOM THERMOSTAT/TRANSMITTER - WALL MOUNT
- (M) ROOM HUMIDISTAT (MOISTURE)/TRANSMITTER - WALL MOUNT
- (TT) TEMPERATURE TRANSMITTER
- (TT) TEMPERATURE TRANSMITTER, AVERAGING ELEMENT
- (MT) MOISTURE (HUMIDITY) TRANSMITTER
- (PT) PRESSURE TRANSMITTER
- (SPS) STATIC PRESSURE SENSOR
- (FT) FLOW TRANSMITTER
- (IT) CURRENT TRANSMITTER
- (CT) CONDUCTIVITY TRANSMITTER
- (SD) SMOKE DETECTOR
- (PDT) PRESSURE DIFFERENTIAL TRANSMITTER
- (PDS) PRESSURE DIFFERENTIAL SWITCH
- (HS) HAND SWITCH (HAND-OFF-AUTO SWITCH)
- (ZC) VALVE OR DAMPER POSITION CONTROLLER
- (KR) LOCAL RECORDING TIME CLOCK (RUNTIME)
- (TSL) TEMPERATURE SWITCH, LOW (FREEZESTAT)
- (TSH) TEMPERATURE SWITCH, HIGH (FREEZESTAT)
- (LC) LEVEL CONTROLLER
- (LT) LEVEL TRANSMITTER

CONTROLS SYMBOLS

- (PSH) PRESSURE SWITCH HIGH
- (PSL) PRESSURE SWITCH LOW
- (EPT) ELECTRONIC TO PNEUMATIC TRANSDUCER
- (AT) CO₂ CARBON DIOXIDE TRANSMITTER
- (AT) CO CARBON MONOXIDE TRANSMITTER
- (AT) OC OCCUPANCY SENSOR
- (LTCP) LOCAL TEMPERATURE CONTROL PANEL
- (HVAC) HVAC CONTROL PANEL
- (VSMC) VARIABLE SPEED MOTOR CONTROLLER
- (ECC) INTEGRATE CONTROL POINT ON REMOTE GRAPHICS WORKSTATION AT ENERGY CONTROL CENTER
- (TC) TEMPERATURE CONTROLLER. SEE SEQUENCE OF OPERATION
- (PC) PRESSURE CONTROLLER. SEE SEQUENCE OF OPERATION
- (SC) SPEED CONTROLLER. SEE SEQUENCE OF OPERATION
- (FC) FLOW CONTROLLER. SEE SEQUENCE OF OPERATION
- (FSH) FLOW SWITCH HIGH
- (FSL) FLOW SWITCH LOW
- (KC) TIME CLOCK CONTROLLING EQUIPMENT ON A SCHEDULE



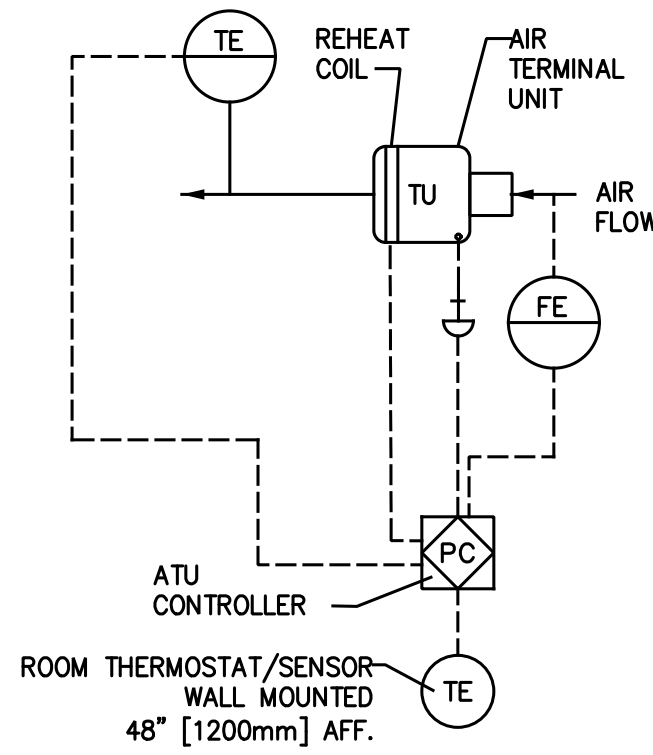
VAV BOX CONTROL SEQUENCE

A. SET POINTS SHALL BE SET AS FOLLOWS:
 COOLING 75F (ADJ)
 HEATING 70F(ADJ)
 DEADBAND OF 5° F BETWEEN HEATING AND COOLING SET POINTS WILL BE MAINTAINED.

B. UPON FALL IN SPACE TEMPERATURE THE VAV DAMPER WILL MODULATE TO MINIMUM POSITION.

C. UPON FURTHER DROP IN SPACE TEMPERATURE ELECTRIC REHEAT COIL WILL MODULATE TO MAINTAIN SET POINT ± .5° F. THE ADJUSTABLE TOLERANCE OF ± .5° F HAS BEEN SELECTED TO PREVENT HUNTING.

D. THE REVERSE SHALL OCCUR ON THE RISE IN SPACE TEMPERATURE.



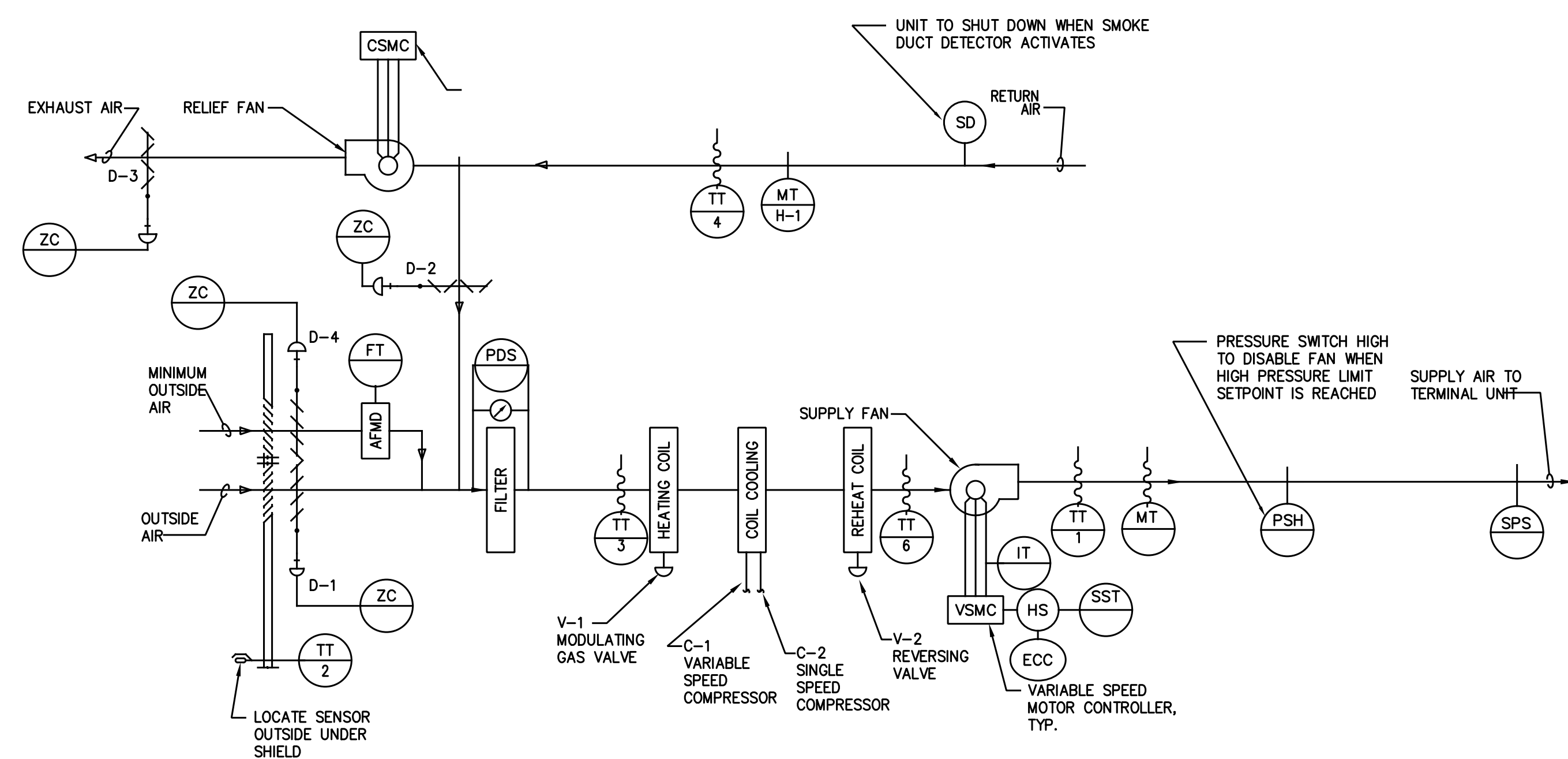
VARIABLE VOLUME AIR TERMINAL UNIT CONTROL DIAGRAM

NOT TO SCALE

JOB: 0555.09 BUILDING: VA SAMPLE POINTS LIST	POINT LEGEND	SYSTEM OUTPUTS		SYSTEM INPUTS		SYSTEM SOFTWARE/CONTROL		PAGE:
		BINARY	ANALOG	BINARY	ANALOG	ALARM PROCESSING	APPLICATION/FUNCTION	
SYSTEM: VAV AIR HANDLER								
SYSTEM COMPONENT:								
Return air Temperature	AI-1	RAT						
Return Air Humidity	AI-2	RAH						
Discharge Air Temperature	AI-7	DAT						
Discharge Static Pressure	AI-8	DASP						
OUTSIDE AIR TEMPERATURE	AI-11	OAT						
RELIEF FAN STATUS	BI-2	RF-ST5						
SUPPLY FAN STATUS	BI-3	SF-ST5						
STATIC PRESSURE HIGH LIMIT	BI-5	SPS-2						
SUPPLY FAN VSMC ALARM	BI-7	SF-ALA						
SUPPLY FAN VSMC	AO-2	SF-SPD						
OUTSIDE AIR DAMPER	AO-3	OAD						
RETURN AIR DAMPER	AO-4	RAD						
EXHAUST AIR DAMPER	AO-5	EAD						
MINIMUM OUTSIDE AIR DAMPER	AO-7	MIN-OAD						
HEATING VALVE V-1	AO-8	PH1-V1						
VARIABLE COMPRESSOR C-1	AO-9	CLG-V1						
SINGLE SPEED COMP. C-2	AO-10	HUM-V4						
REHEAT REVER. VALVE V-2	BO-3	HUM-ISO-V3						
RELIEF FAN START/STOP	BO-1	RF-SST						
SUPPLY FAN START/STOP	BO-2	SF-SST						

POINTS LIST FOR VAV AIR HANDLING UNIT WITH MINIMUM OUTSIDE AIR

NOT TO SCALE



VARIABLE AIR VOLUME AIR HANDLING UNIT WITH MINIMUM OUTSIDE AIR CONTROL DIAGRAM

NOT TO SCALE

SEQUENCE OF OPERATION FOR VARIABLE AIR VOLUME AIR HANDLING UNIT WITH MINIMUM OUTSIDE AIR

1. GENERAL

1.1 UNIT IS NORMALLY STARTED AND STOPPED REMOTELY AT THE ECC. H-O-A SWITCH SHALL BE KEPT IN THE "AUTO" POSITION. "HAND" AND "OFF" POSITIONS SHALL BE USED ONLY FOR MAINTENANCE. WHEN THE UNIT IS "OFF" D-1, D-3, SHALL BE FULLY CLOSED. WHEN THE UNIT IS "ON" D-1, SD-1 AND SD-2 SHALL BE FULLY OPEN. D-2 AND D-3 SHALL MODULATE IN ACCORDANCE WITH THE FOLLOWING SEQUENCE:

2. TEMPERATURE CONTROL

- 2.1 SUPPLY AIR TEMPERATURE, SENSED BY TT-1, SHALL BE MAINTAINED AT SETPOINT VIA DIGITAL CONTROL PANEL BY MODULATING V-1 OR C-1 AND C-2 OR D-2 AND D-3.
- 2.2 WHEN THE TEMPERATURE OF THE OUTSIDE AIR, SENSED BY TT-2, IS ABOVE 75F (ADJ) [23.8°C], THE DIGITAL CONTROL PANEL SHALL PREVENT THE MODULATION OF D-2 AND D-3 AND SHALL ASSUME THE MINIMUM OUTSIDE AIR POSITION (D-2 FULLY OPENED AND D-3 FULLY CLOSED). THE DIGITAL CONTROL PANEL SHALL MODULATE V-1 OR C-1 TO MAINTAIN THE SUPPLY AIR TEMPERATURE, SENSED BY TT-1.
- 2.3 WHEN THE TEMPERATURE OF THE OUTSIDE AIR, SENSED BY TT-2, IS BETWEEN 65F (18.3°C) AND THE SUPPLY AIR TEMPERATURE SENSED BY TT-1, DAMPER D-2 SHALL FULLY CLOSE AND D1 AND D3 SHALL BE FULLY OPEN (MAXIMUM OUTSIDE AIR POSITION). THE DIGITAL CONTROL PANEL SHALL MODULATE V-1 TO MAINTAIN THE SUPPLY AIR TEMPERATURE, SENSED BY TT-1.
- 2.4 WHEN THE TEMPERATURE OF THE OUTSIDE AIR, SENSED BY TT-2, IS BELOW THE SUPPLY AIR TEMPERATURE, SENSED BY TT-1, DAMPERS D1, D-2 AND D-3 SHALL MODULATE TO MAINTAIN THE SCHEDULED SUPPLY AIR TEMPERATURE. IF D-2 IS OPEN AND D-3 IS CLOSED TO MINIMUM OUTSIDE AIR, V-1 SHALL MODULATE OPEN TO MAINTAIN THE SUPPLY AIR TEMPERATURE, SENSED BY TT-1.

3. AIR FLOW CONTROL

- 3.1 THE SUPPLY AIR FLOW SHALL BE CONTROLLED BY THE DIGITAL CONTROL PANEL MODULATING THE SUPPLY FAN VARIABLE SPEED MOTOR CONTROLLER TO MAINTAIN 1.0" [25mm] OF DUCT STATIC PRESSURE (FIELD ADJUSTABLE). SENSED BY SPS-1. RESET STATIC PRESSURE BASED ON ACTUAL BUILDING LOAD BY POLLING ALL ATU
- 3.2 THE DIGITAL CONTROL PANEL, USING TOTAL SUPPLY AIR AND RETURN AIR FLOW SIGNALS, SHALL RESET THE RETURN AIR FAN VSMC TO MAINTAIN A CONSTANT AIR FLOW DIFFERENCE BETWEEN THE SUPPLY AIR AND THE RETURN AIR EQUAL TO MINIMUM OUTSIDE AIR.
- 3.3 USING HIGH PRESSURE SENSOR SPS-2 LOCATED AT THE SUPPLY FAN DISCHARGE, SHALL PREVENT THE SUPPLY FAN FROM DEVELOPING OVER 3" [75mm] OF STATIC PRESSURE (FIELD ADJUSTABLE). IF STATIC PRESSURE AT SPS-2 DOES EXCEED 3" [75mm] THE SUPPLY AIR FAN SHALL STOP. SPS-2 SHALL BE HARDWIRED TO THE SUPPLY FAN VSMC AND UNIT SHALL BE SHUTDOWN IN HAND/AUTO OR BYPASS MODE. SPS-2 WILL REQUIRE MANUAL RESET AT THE DEVICE.

4. HUMIDITY CONTROL

- 4.1 WHEN THE DIGITAL CONTROL PANEL IS NOT CALLING FOR DEHUMIDIFICATION, SENSED BY RETURN AIR HUMIDITY H-1, THE HOT GAS REHEAT REVERSING VALVE SHALL ACTIVATE. WHEN THE DIGITAL CONTROL PANEL IS CALLING FOR DEHUMIDIFICATION, C-1 SHALL REMAIN ENERGIZED. RETURN AIR HUMIDITY SHALL BE MAINTAINED AT SETPOINT OF 60% RH (ADJ).

5. AUTOMATIC SHUTDOWN/RESTART

- 5.1 WHEN SMOKE IS DETECTED BY DUCT SMOKE DETECTOR, SD, THE SUPPLY FAN SHALL SHUT "OFF" AND AN ALARM SIGNAL SHALL BE TRANSMITTED TO THE FIRE ALARM SYSTEM.
- 5.2 EXHAUST FANS SERVING AREA OF THE SUPPLY FAN SHALL CONTINUE TO RUN. SUPPLY AND RETURN FANS SHALL RESTART AND SMOKE DAMPERS SHALL OPEN WHEN FIRE ALARM CIRCUIT IS RESET.

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REVISIONS:

BOONE COUNTY PUBLIC SAFETY CAMPUS
BOONE COUNTY SHERIFF
 3000 CONRAD LANE
 BURLINGTON, KY 41005

PROJECT:

SHEET TITLE: HVAC CONTROL DETAILS

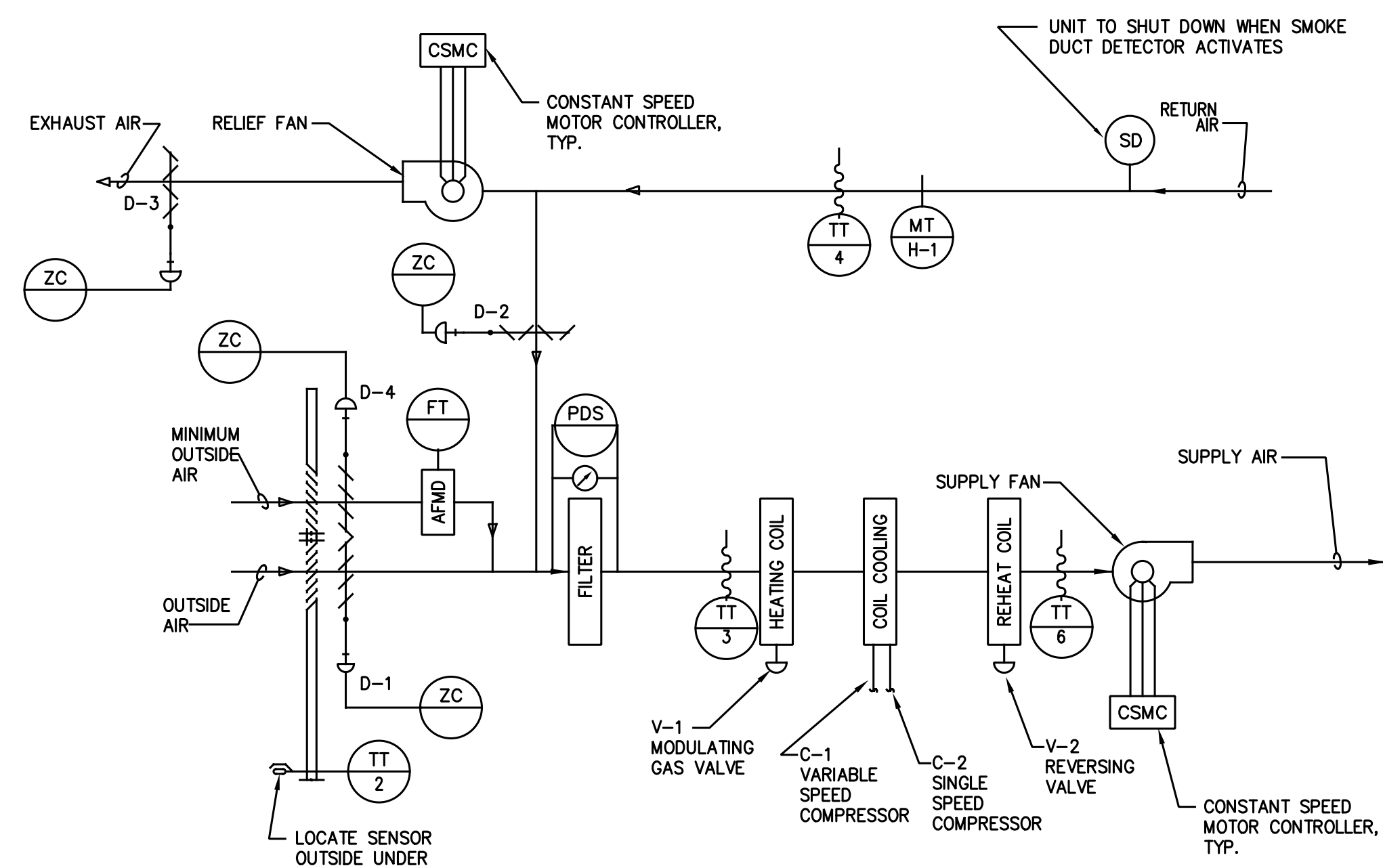
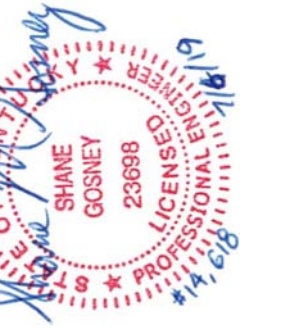
DRN: SMG
 CHK: SMG
 CAD REF: 14618M-1

DATE: 07-05-19
 JOB NO: 14618

SHEET No.:

M-4.0

ISSUED FOR BIDDING



CONSTANT AIR VOLUME ROOFTOP UNIT CONTROL DIAGRAM

NOT TO SCALE

SEQUENCE OF OPERATION FOR CONSTANT AIR VOLUME AIR ROOFTOP UNIT

1. GENERAL
 - 1.1 UNIT IS NORMALLY STARTED AND STOPPED REMOTELY AT THE ECC. H-0-A SWITCH SHALL BE KEPT IN THE "AUTO" POSITION. "HAND" AND "OFF" POSITIONS SHALL BE USED ONLY FOR MAINTENANCE. WHEN THE UNIT IS "OFF" D-1, D-3, SHALL BE FULLY CLOSED. WHEN THE UNIT IS "ON" D-1, SD-1 AND SD-2 SHALL BE FULLY OPEN. D-2 AND D-3 SHALL MODULATE IN ACCORDANCE WITH THE FOLLOWING SEQUENCE:
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 - 2.3 WHEN THE TEMPERATURE OF THE OUTSIDE AIR, SENSED BY TT-2, IS BETWEEN 65°F [18.3°C] AND THE SUPPLY AIR TEMPERATURE SENSED BY TT-1, DAMPER D-2 SHALL FULLY CLOSE AND D1 AND D3 SHALL BE FULLY OPEN (MAXIMUM OUTSIDE AIR POSITION). THE DIGITAL CONTROL PANEL SHALL MODULATE V-1 TO MAINTAIN THE SUPPLY AIR TEMPERATURE, SENSED BY TT-1.
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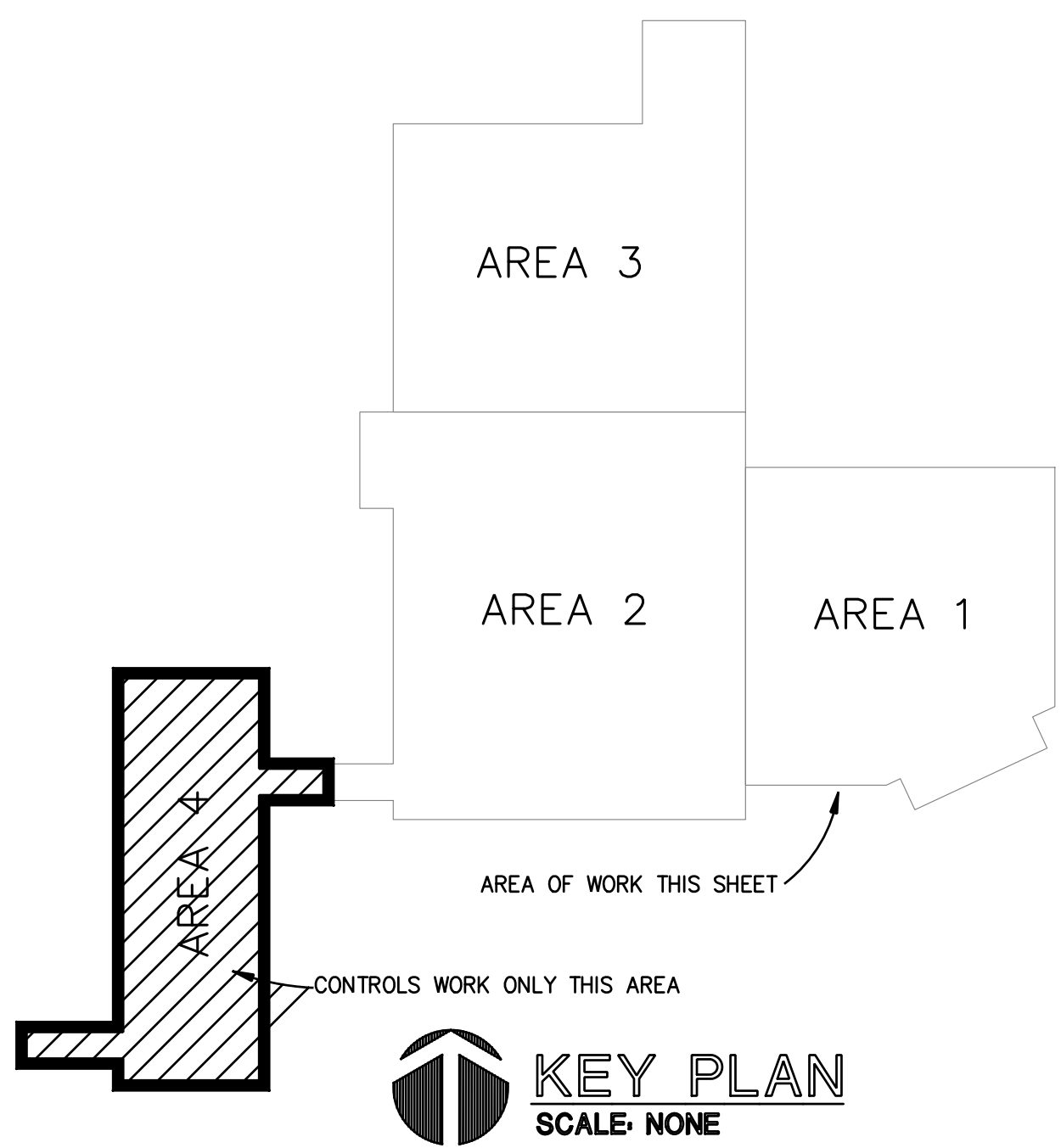
SYSTEM COMPONENT	POINT ID	ABBREVIATION	POINT LEGEND	SYSTEM OUTPUTS		SYSTEM INPUTS			SYSTEM SOFTWARE/CONTROL		PAGE:
				BINARY	ANALOG	BINARY	ANALOG	ALARM PROCESSING	APPLICATION/FUNCTION		
SYSTEM:											
VAV AIR HANDLER											
SYSTEM COMPONENT:											
Return air Temperature	AI-1	RAT									
Return Air Humidity	AI-2	RAH									
Discharge Air Temperature	AI-7	DAT									
OUTSIDE AIR TEMPERATURE	AI-11	OAT									
RELIEF FAN STATUS	BI-2	RF-SFS									
SUPPLY FAN STATUS	BI-3	SF-SFS									
SUPPLY FAN CSMC	AO-2	SF-SFD									
OUTSIDE AIR DAMPER	AO-3	OAD									
RETURN AIR DAMPER	AO-4	RAD									
EXHAUST AIR DAMPER	AO-5	EAD									
MINIMUM OUTSIDE AIR DAMPER	AO-7	MIN-OAD									
HEATING VALVE V-1	AO-8	PH1-V1									
VARIABLE COMPRESSOR C-1	AO-9	CLC-V1									
SINGLE SPEED COMP. C-2	AO-10	HUM-V4									
REHEAT REVER. VALVE V-2	BO-3	HUM-ISO-V3									
RELIEF FAN START/STOP	BO-1	RF-SST									
SUPPLY FAN START/STOP	BO-2	SF-SST									

POINTS LIST FOR CAV AIR HANDLING UNIT WITH MINIMUM OUTSIDE AIR

NOT TO SCALE

CONTROLS NOTES FOR EXISTING EQUIPMENT TO REMAIN
EXISTING HVAC EQUIPMENT THAT WILL NOT BE EFFECTED AS PART OF THE NEW WORK SHALL MAINTAIN THEIR CONTROL FUNCTIONS ON THE NEW BAS.

CONTROLS NOTES FOR EXISTING SHOOTING RANGE (AREA 4)
THE EXISTING RIFLE RANGE IS SERVED BY AN EXISTING AIR HANDLER AND EXHAUST FAN THAT SHALL REMAIN IN PLACE. CONNECT THE NEW CONTROLS SYSTEM TO THE EXISTING POINTS IN THE SHOOTING RANGE VIA A GATEWAY. OCCUPIED/UNOCCUPIED, ON/OFF, AND SCHEDULING FUNCTIONS FOR THE SHOOTING RANGE SHALL BE AVAILABLE AT THE BAS WORKSTATION.



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HAL-PE ASSOCIATES
ENGINEERING SERVICES, INC.
530 W. 9TH ST.
NEWPORT, KY 41071
859.431.6083
halpe.com

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE: **HVAC CONTROL DETAILS**

DRN: SMG
CHK: SMG
CAD REF: 14618M-1
DATE: 07-05-19
JOB NO.: 14618
SHEET No.: **M-4.1**

ISSUED FOR BIDDING

CONSTRUCTION NOTES

1. NEW PANEL "H3" TO BE INSTALLED BETWEEN EXISTING PANELS.

GENERAL NOTES

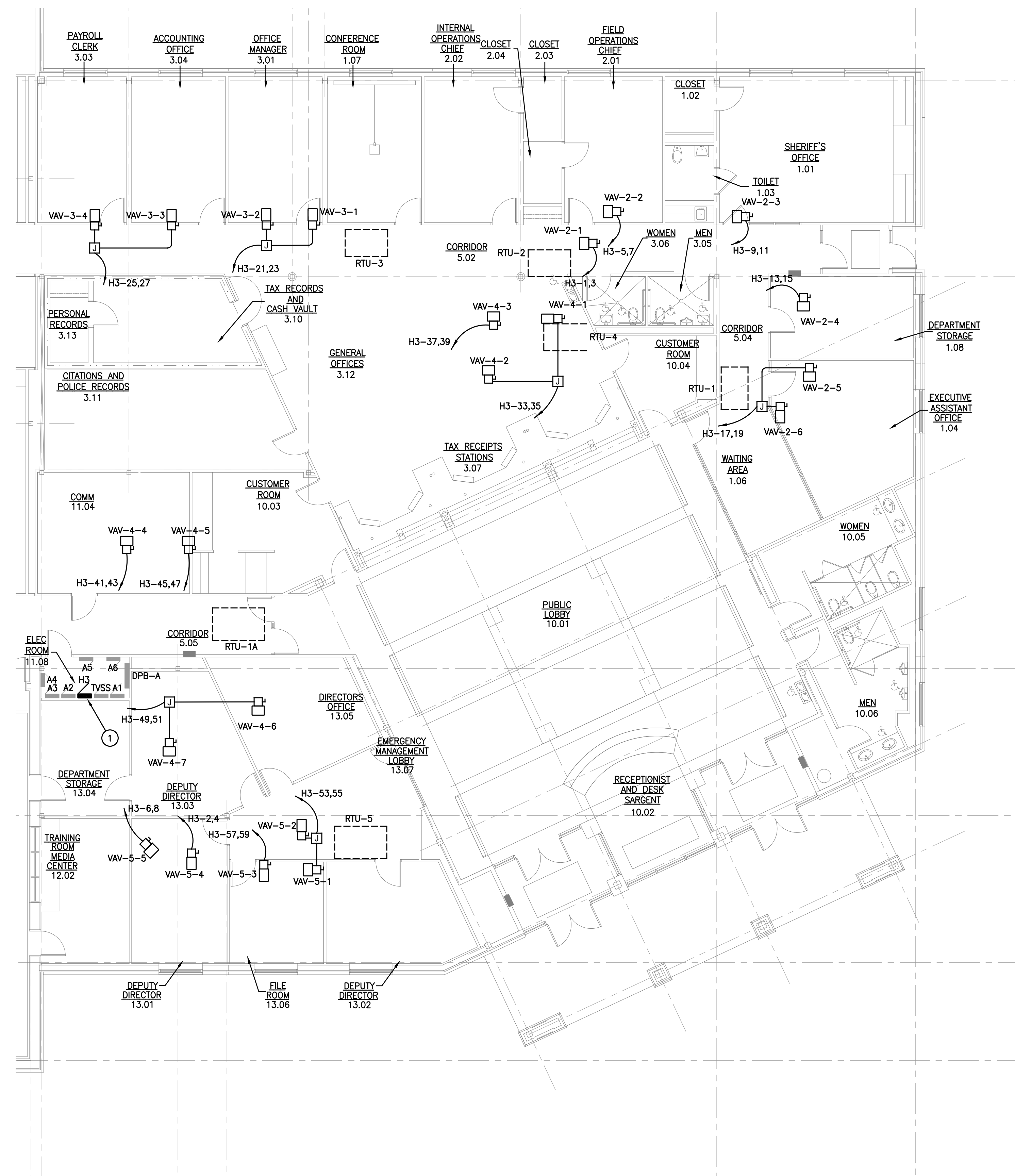
- ALL PIECES OF EQUIPMENT TO BE PROVIDED WITH A LOCKABLE MEANS OF DISCONNECT WITHIN SIGHT OF THE EQUIPMENT.
- IF MULTIPLE PIECES OF EQUIPMENT ARE POWERED THROUGH THE SAME CIRCUIT, THE EQUIPMENT MUST BE WIRED SUCH THAT EACH INDIVIDUAL PIECE OF EQUIPMENT CAN BE SERVICED WITHOUT CUTTING POWER TO THE REMAINING PIECES OF EQUIPMENT ON THAT CIRCUIT.
- DUCT SMOKE DETECTORS ARE TO BE REPLACED AT EACH ROOFTOP UNIT. CONTRACTOR IS RESPONSIBLE FOR ENSURING ALL REPLACED SMOKE DETECTORS ARE PROPERLY MONITORED THROUGH THE EXISTING FIRE ALARM SYSTEM.

HVAC ELECTRICAL SCHEDULE						
MARK	COMPONENT	FLA	VOLT/PHASE	EXISTING WIRE/CONDUIT	EXISTING DISCONNECT	OLD BREAKER / NEW BREAKER / CIRCUIT
RTU-1	COMPRESSOR	15	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC1-1,3,5 / 25A 3P
	FAN	8	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-1,3,5 / 15A 3P
RTU-1A	COMPRESSOR	15	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC1-7,9,11 / 25A 3P
	FAN	6	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-7,9,11 / 15 3P
RTU-2	COMPRESSOR	20	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC1-13,15,17 / 40A 3P
	FAN	9	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-13,15,17 / 15 3P
RTU-3	COMPRESSOR	15	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F25	30A AC1-19,21,23 / 25 3P
	FAN	13	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-19,21,23 / 20 3P
RTU-4	COMPRESSOR	31	208V/3Ø	4 #6 THHN 1" C.	60A 3P F55	60A AC1-25,27,29 / 60 3P
	FAN	22	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-25,27,29 / 35 3P
RTU-5	COMPRESSOR	15	208V/3Ø	4 #10 THHN 1/2" C.	30A 3P F25	30A AC1-31,33,35 / 25 3P
	FAN	6	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-31,33,35 / 15 3P
RTU-6	COMPRESSOR	19	208V/3Ø	4 #10 THHN 1/2" C.	30A 3P F30	30A AC1-37,39,41 / 35 3P
	FAN	6	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-37,39,41 / 15 3P
RTU-7	COMPRESSOR	19	208V/3Ø	4 #10 THHN 1/2" C.	30A 3P F30	30A AC1-2,4,6 / 30 3P
	FAN	8	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-2,4,6 / 15 3P
RTU-8	COMPRESSOR	20	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC1-8,10,12 / 40 3P
	FAN	9	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-8,10,12 / 15 3P
RTU-9	COMPRESSOR	19	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC1-14,16,18 / 35 3P
	FAN	9	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-14,16,18 / 15 3P
RTU-10	COMPRESSOR	20	208V/3Ø	4 #6 THHN 3/4" C.	60A 3P F40	40A AC1-20,22,24 / 40 3P
	FAN	9	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-20,22,24 / 15 3P
RTU-11	COMPRESSOR	35	208V/3Ø	4 #6 THHN 1" C.	60A 3P F60	60A AC1-26,28,30 / 50 3P
	FAN	18	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H1-26,28,30 / 25 3P
RTU-12	COMPRESSOR	20	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC2-1,3,5 / 40 3P
	FAN	8	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H2-1,3,5 / 15 3P
RTU-13	COMPRESSOR	31	208V/3Ø	4 #6 THHN 1" C.	60A 3P F60	60A AC2-7,9,11 / 60 3P
	FAN	19	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H2-7,9,11 / 30 3P
RTU-14	COMPRESSOR	15	208V/3Ø	4 #10 THHN 1/2" C.	30A 3P F25	30A AC2-13,15,17 / 25 3P
	FAN	6	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H2-13,15,17 / 15 3P
RTU-15	COMPRESSOR	15	208V/1Ø	3 #10 THHN 1/2" C.	30A 3P F30	30A AC2-19,21 / 25 2P
	FAN	8	208V/1Ø	3 #12 THHN 1/2" C.	30A 2P F20	30A H2-19,21 / 15 2P
RTU-16	COMPRESSOR	15	208V/1Ø	3 #12 THHN 1/2" C.	30A 2P F20	20A REMOVED
	FAN	6	208V/1Ø	3 #12 THHN 1/2" C.	30A 2P F20	20A REMOVED
RTU-17	COMPRESSOR	23	208V/3Ø	4 #6 THHN 1" C.	60A 3P F60	60A AC2-27,29,31 / 45 3P
	FAN	11	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H2-27,29,31 / 20 3P
RTU-18	COMPRESSOR	20	208V/3Ø	4 #6 THHN 1" C.	60A 3P F50	50A AC2-33,35,37 / 40 3P
	FAN	8	208V/3Ø	4 #12 THHN 1/2" C.	30A 3P F20	20A H2-33,35,37 / 15 3P
RTU-19	COMPRESSOR	15	208V/1Ø	3 #10 THHN 1/2" C.	30A 3P F30	30A AC2-39,41 / 25 2P
	FAN	6	208V/1Ø	3 #12 THHN 1/2" C.	30A 2P F20	20A H2-39,41 / 15 2P

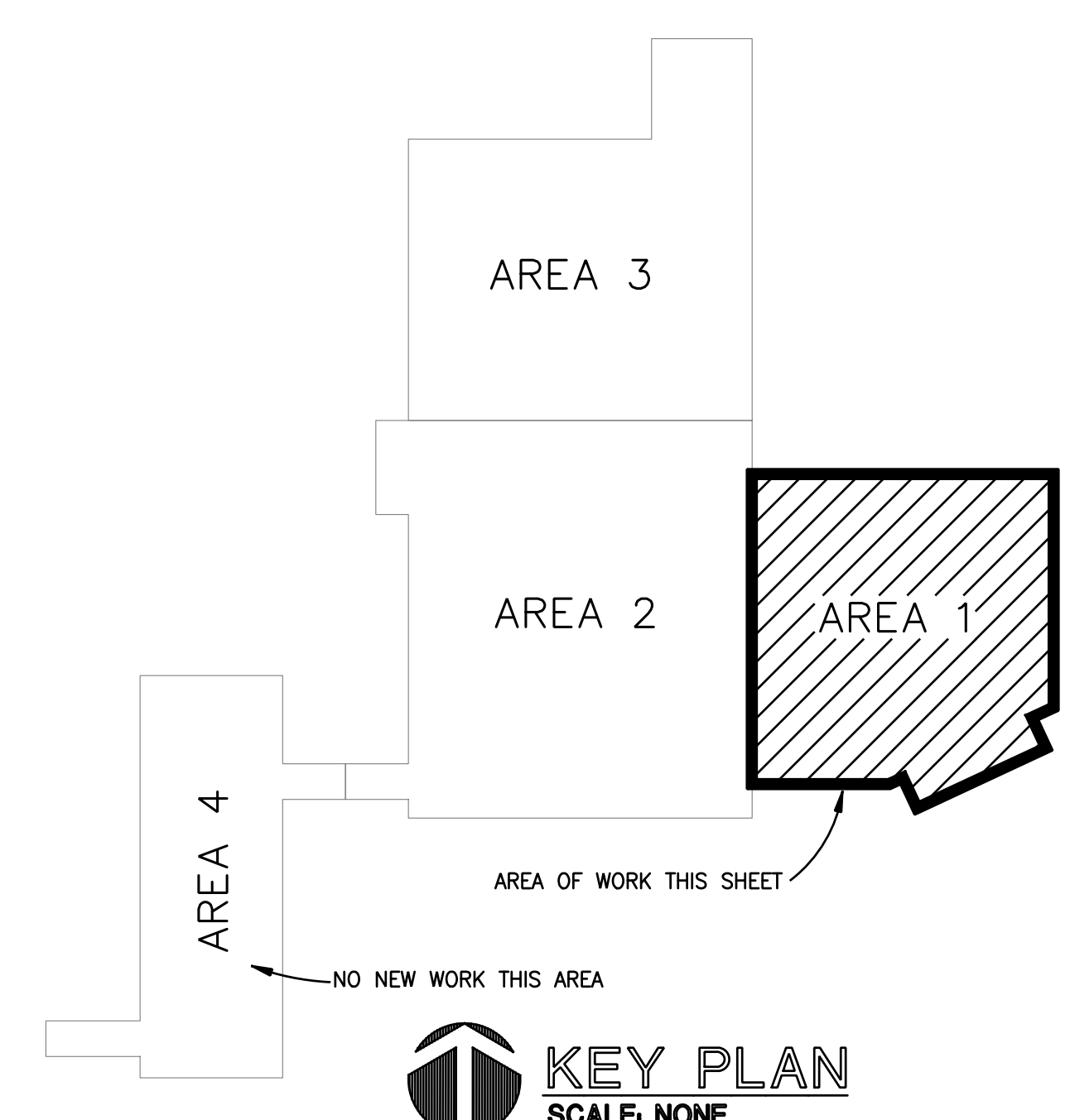
NOTE: EXISTING WIRE SIZES, EXISTING DISCONNECT AND FUSE SIZES, AND EXISTING BREAKER SIZES HAVE BEEN SHOWN TO INFORM THE CONTRACTOR OF EXISTING CONDITIONS. EXISTING EQUIPMENT, CABLES, ETC. MAY BE USED IF THEY MEET THE ELECTRICAL REQUIREMENTS AND THE CONTRACTOR CHOOSES TO USE THEM. IF THEY DO NOT MEET THE ELECTRICAL REQUIREMENTS, NEW BREAKERS, CABLES, ETC. MUST BE PROVIDED AND INSTALLED TO MEET THE ELECTRICAL REQUIREMENTS OF THE NEW EQUIPMENT.

ELECTRICAL LEGEND

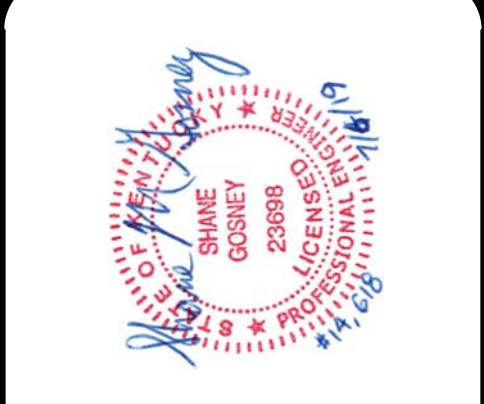
- | | | | |
|--|---|--|--|
| | DUPLEX CONVENIENCE OUTLET | | NOTE SYMBOL - NOTE #2 |
| | QUADPLEX OUTLET | | CIRCUIT HOME RUN - CKT. #A-1 |
| | GROUND FAULT INTERRUPTER/ WEATHERPROOF OUTLET | | CIRCUIT HOME RUN - CKT. #A-1 & 2 WITH SHARED NEUTRAL |
| | GROUND FAULT CIRCUIT INTERRUPTER | | EXPOSED CONDUIT |
| | SPECIAL PURPOSE OUTLET | | CONDUIT CONCEALED IN OR UNDER FLOOR |
| | JUNCTION BOX | | WIRING TURNED UP |
| | SURFACE MTD ELECTRIC PANEL | | WIRING TURNED DOWN |
| | RECESSED ELECTRIC PANEL | | F.A. MANUAL STATION |
| | MOTOR SYMBOL | | F.A. HORN |
| | FUSED DISCONNECT SWITCH | | SMOKE DETECTOR W/AUX RELAY |
| | NON-FUSED DISCONNECT SWITCH | | HEAT DETECTOR |
| | STARTER | | DUCT DETECTOR |
| | MOTOR STARTER w/THERMAL OVERLOADS | | ANNUNCIATOR PANEL |
| | DISCONNECT SWITCH INFORMATION | | FIRE ALARM CONTROL PANEL |



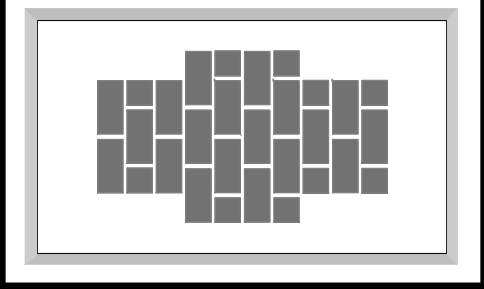
AREA 1 - ELECTRIC FLOOR PLAN
SCALE: 1/8" = 1'-0"



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HAL-PE ASSOCIATES
ENGINEERING SERVICES, INC.
530 W. 9TH ST.
NEWPORT, KY 41071
859.431.6083
halpe.com



REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

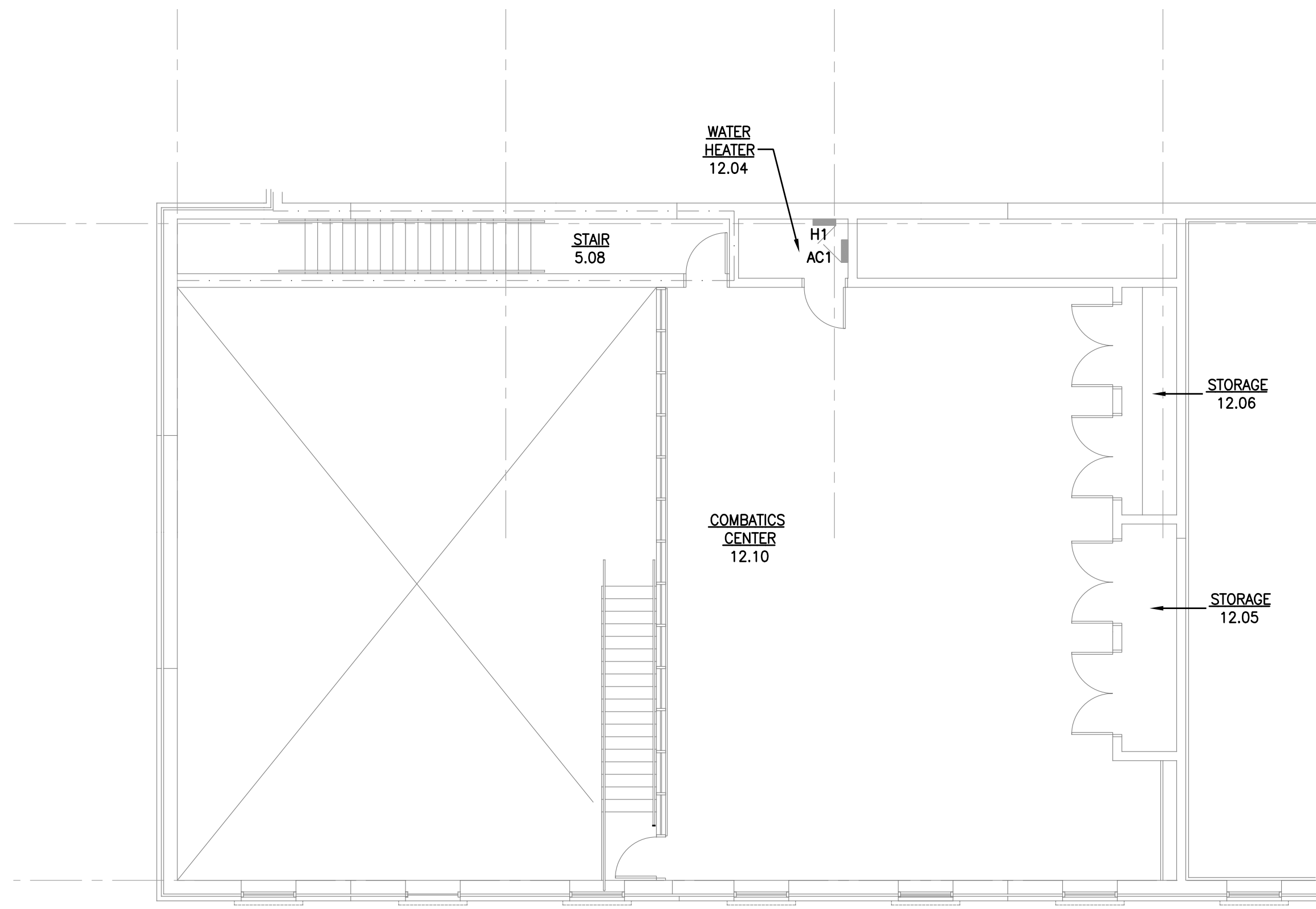
SHEET TITLE: **AREA 1 - ELECTRIC FLOOR PLAN**

DRN: CHK: CAD REF:
DRG SMG 14618E-1

DATE: JOB NO.
07-05-19 14618

SHEET No.:
E-1.0

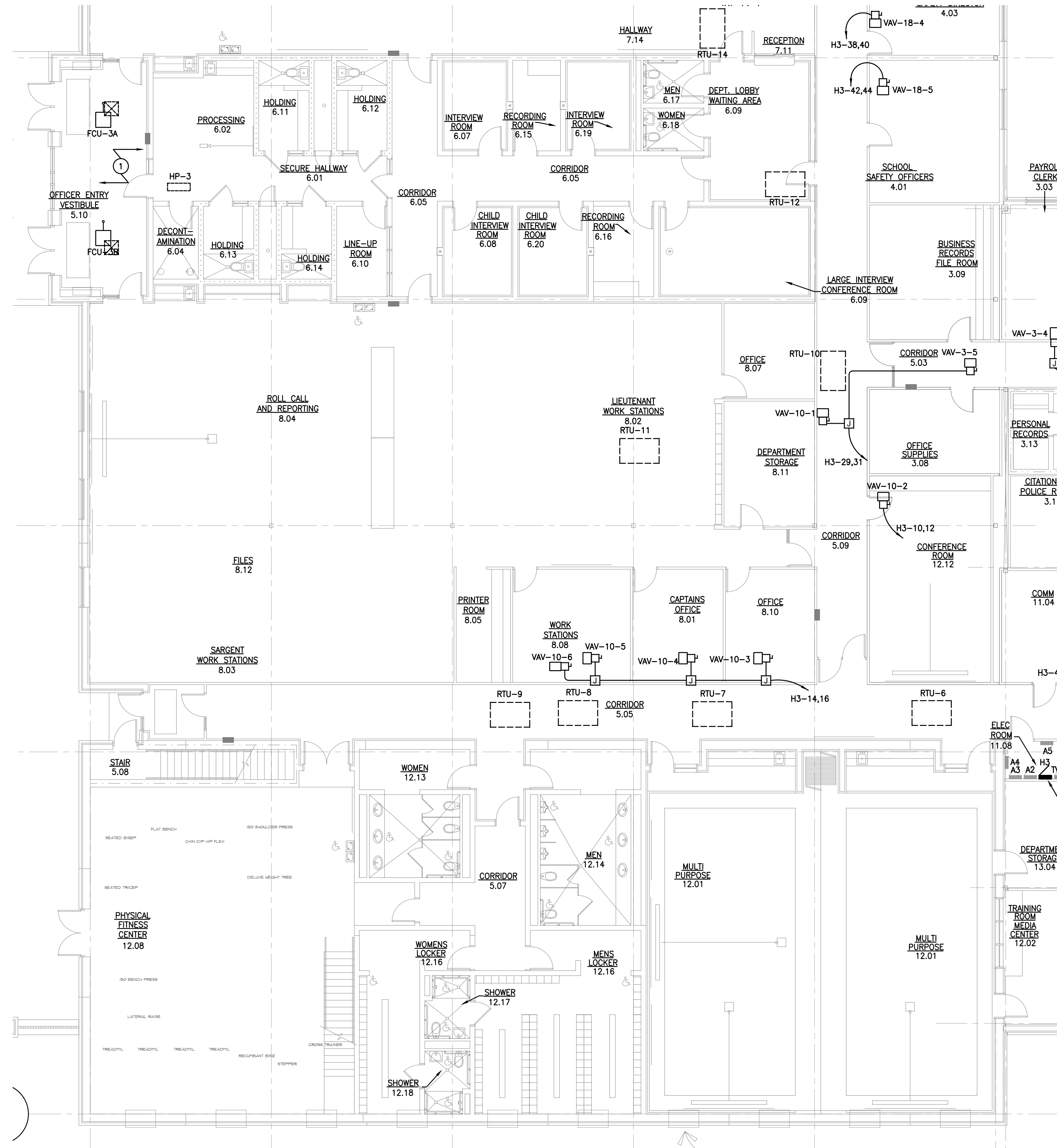
ISSUED FOR BIDDING



AREA 2 UPPER LEVEL - ELECTRIC FLOOR PLAN
SCALE: 1/8" = 1'-0"

CONSTRUCTION NOTES

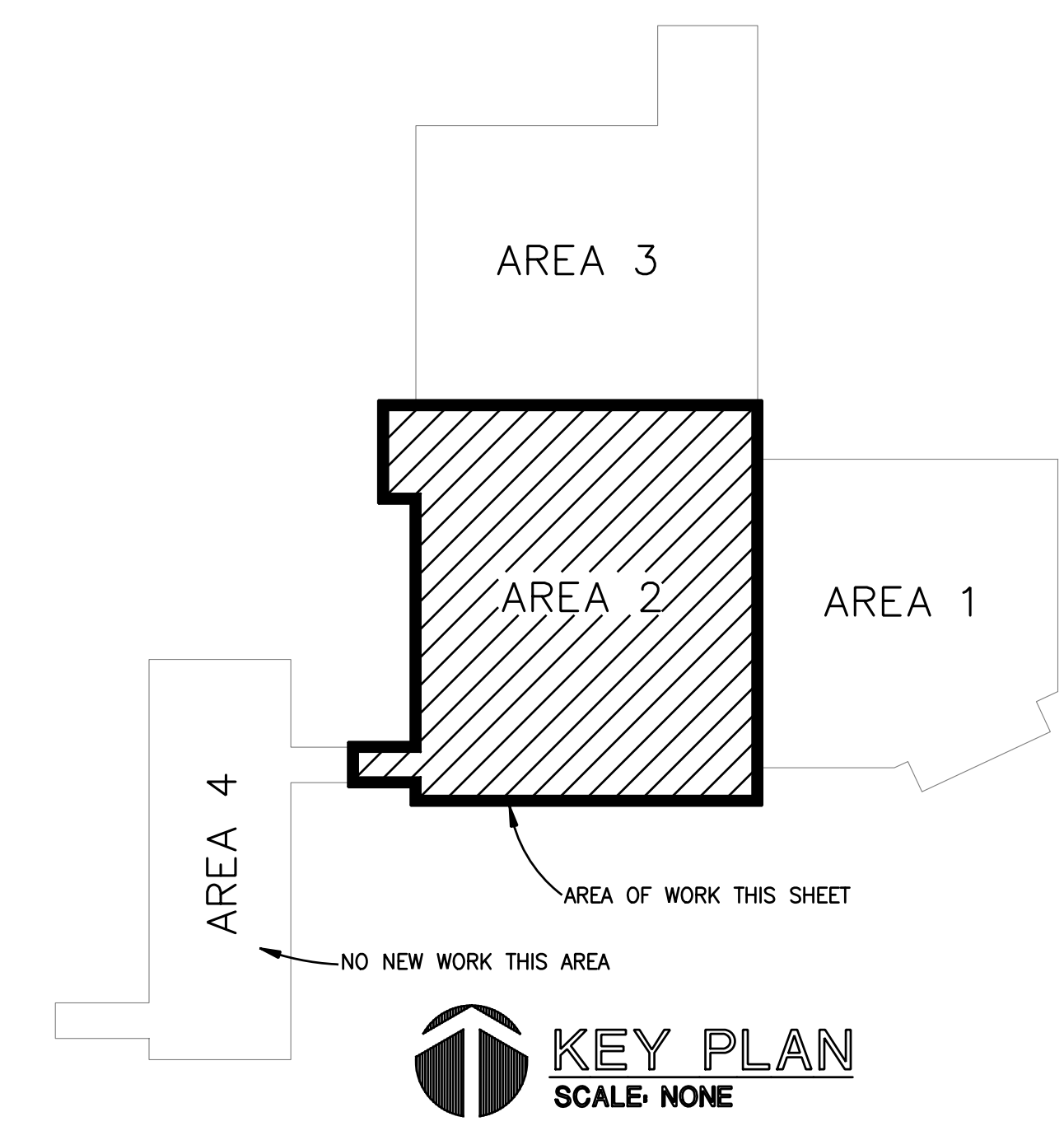
- CONTRACTOR IS TO REMOVE THE CABLES, CONDUITS, ETC FROM THE EXISTING (6) 1500W RADIATORS IN THE VESTIBULE, BACK TO THE NEAREST JUNCTION BOX. CONTRACTOR SHOULD THEN VALIDATE EXACTLY WHICH PANEL FROM WHICH THE CIRCUITS WERE POWERED IN ELECTRIC ROOM 11.08. THE INTENT IS TO THEN REMOVE THE RADIATOR CIRCUIT BREAKERS AND REPLACE THEM WITH A SINGLE 35A 2-POLE CIRCUIT BREAKER FOR HEAT PUMP 3.



AREA 2 - ELECTRIC FLOOR PLAN
SCALE: 1/8" = 1'-0"

ELECTRICAL LEGEND

- | | | | |
|--|---|--|--|
| | DUPLEX CONVENIENCE OUTLET | | NOTE SYMBOL - NOTE #2 |
| | QUADPLEX OUTLET | | CIRCUIT HOME RUN - CKT. #A-1 |
| | GROUND FAULT INTERRUPTER/ WEATHERPROOF OUTLET | | CIRCUIT HOME RUN - CKT. #A-1 & 2. WITH SHARED NEUTRAL. |
| | GROUND FAULT CIRCUIT INTERRUPTER | | EXPOSED CONDUIT |
| | SPECIAL PURPOSE OUTLET | | CONDUIT CONCEALED IN OR UNDER FLOOR |
| | JUNCTION BOX | | WIRING TURNED UP |
| | SURFACE MTD ELECTRIC PANEL | | WIRING TURNED DOWN |
| | RECESSED ELECTRIC PANEL | | F.A. MANUAL STATION |
| | MOTOR SYMBOL | | F.A. HORN |
| | FUSED DISCONNECT SWITCH | | SMOKE DETECTOR W/AUX RELAY |
| | NON-FUSED DISCONNECT SWITCH | | HEAT DETECTOR |
| | STARTER | | DUCT DETECTOR |
| | MOTOR STARTER w/THERMAL OVERLOADS | | ANNUNCIATOR PANEL |
| | DISCONNECT SWITCH INFORMATION | | FIRE ALARM CONTROL PANEL |

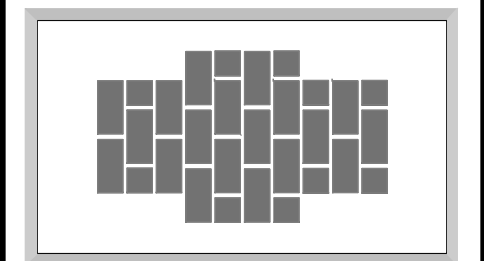


KEY PLAN
SCALE: NONE

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530 W. 9TH ST.
NEWPORT, KY 41071
859.431.6083
halpe.com



REVISIONS:

PROJECT: **BOONE COUNTY PUBLIC SAFETY CAMPUS**
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY, 41005

SHEET TITLE: **AREA 2 - ELECTRIC FLOOR PLAN**

DRN: CHK: CAD REF:
DRG SMG 14618E-1
DATE: JOB NO.
07-05-19 14618
SHEET No.:
E-1.1

ISSUED FOR BIDDING

CONSTRUCTION NOTES

1. ALL EXISTING ROOFTOP UNITS ARE TO BE REPLACED WITH NEW, EXCEPT FOR UNIT 16, WHICH IS TO BE REMOVED. EACH NEW ROOFTOP UNIT IS TO BE SUPPLIED WITH A NEW ROOFTOP ADAPTER CURB WHICH WILL ACTUALLY CAUSE THE NEW UNITS TO RAISE ABOVE THE HEIGHT OF THE ORIGINAL UNITS. IN ADDITION, THE DISCONNECTS ON THE UNIT MAY BE REQUIRED TO BE MOVED. THIS MEANS THE TWO SETS OF ELECTRICAL CABLES TO EACH UNIT MAY BE TOO SHORT ONCE THE NEW UNIT IS IN PLACE. THE CONTRACTOR SHOULD INCLUDE PRICING TO EXTEND BOTH THE EMERGENCY AND THE NORMAL POWER FEEDERS TO ALL ROOFTOPS, TO THE NEW DISCONNECT LOCATIONS, USING THE APPROPRIATELY RATED ENCLOSURES, SPLICES, AND FEEDERS. A DEDUCT IS TO BE APPLIED FOR EACH FEEDER THAT IS NOT REQUIRED TO BE EXTENDED. CONTRACTOR ALSO REQUIRED TO EXTEND EXISTING SMOKE DETECTOR NOTIFICATION CABLES TO NEW LOCATIONS AS REQUIRED FOR NEW UNITS.

GENERAL NOTES

1. UNIT FANS ARE POWERED THROUGH THE GENERATOR'S EMERGENCY CIRCUITS. UNIT CONDENSORS ARE POWERED SEPARATELY THROUGH NORMAL POWER CIRCUITS. DISCONNECTS ARE NOT SHOWN ON THE PLANS, BUT TWO ARE REQUIRED AT EACH UNIT.

DEDUCTION #1

1. DEDUCTION #1 IS A PER FEEDER/DISCONNECT COST GIVEN BACK TO THE OWNER WHENEVER EXISTING RTU FEEDERS ARE LONG ENOUGH TO REACH NEW DISCONNECT LOCATIONS WITHOUT HAVING TO BE EXTENDED. NOTE: THERE ARE TWO SETS OF FEEDERS TO EACH UNIT, THUS THERE CAN BE TWO DEDUCTIONS PER RTU.



ELECTRICAL LEGEND

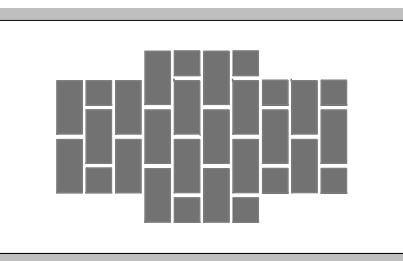
- | | | | |
|--|---|--|--|
| | DUPLEX CONVENIENCE OUTLET | | NOTE SYMBOL - NOTE #2 |
| | QUADPLEX OUTLET | | CIRCUIT HOME RUN - CKT. #A-1 |
| | GROUND FAULT INTERRUPTER/ WEATHERPROOF OUTLET | | CIRCUIT HOME RUN - CKT. #A-1 & 2. WITH SHARED NEUTRAL. |
| | GROUND FAULT CIRCUIT INTERRUPTER | | EXPOSED CONDUIT |
| | SPECIAL PURPOSE OUTLET | | CONDUIT CONCEALED IN OR UNDER FLOOR |
| | JUNCTION BOX | | WIRING TURNED UP |
| | SURFACE MTD ELECTRIC PANEL | | WIRING TURNED DOWN |
| | RECESSED ELECTRIC PANEL | | F.A. MANUAL STATION |
| | MOTOR SYMBOL | | F.A. HORN |
| | FUSED DISCONNECT SWITCH | | SMOKE DETECTOR W/AUX RELAY |
| | NON-FUSED DISCONNECT SWITCH | | HEAT DETECTOR |
| | STARTER | | DUCT DETECTOR |
| | MOTOR STARTER w/THERMAL OVERLOADS | | ANNUNCIATOR PANEL |
| | DISCONNECT SWITCH INFORMATION | | FIRE ALARM CONTROL PANEL |

ELECTRIC ROOF PLAN
SCALE: 1/16" = 1'-0"

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530 W. 9TH ST.
NEWPORT, KY 41071
859.431.6083
halpe.com



REVISIONS:

PROJECT: BOONE COUNTY PUBLIC SAFETY CAMPUS
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY 41005

SHEET TITLE: ELECTRIC ROOF PLAN

DRN:	CHK:	CAD REF:
DRG	SMG	14618E-1
DATE:	JOB NO.	
07-05-19	14618	
SHEET No.:		
E-1.3		

ISSUED FOR BIDDING



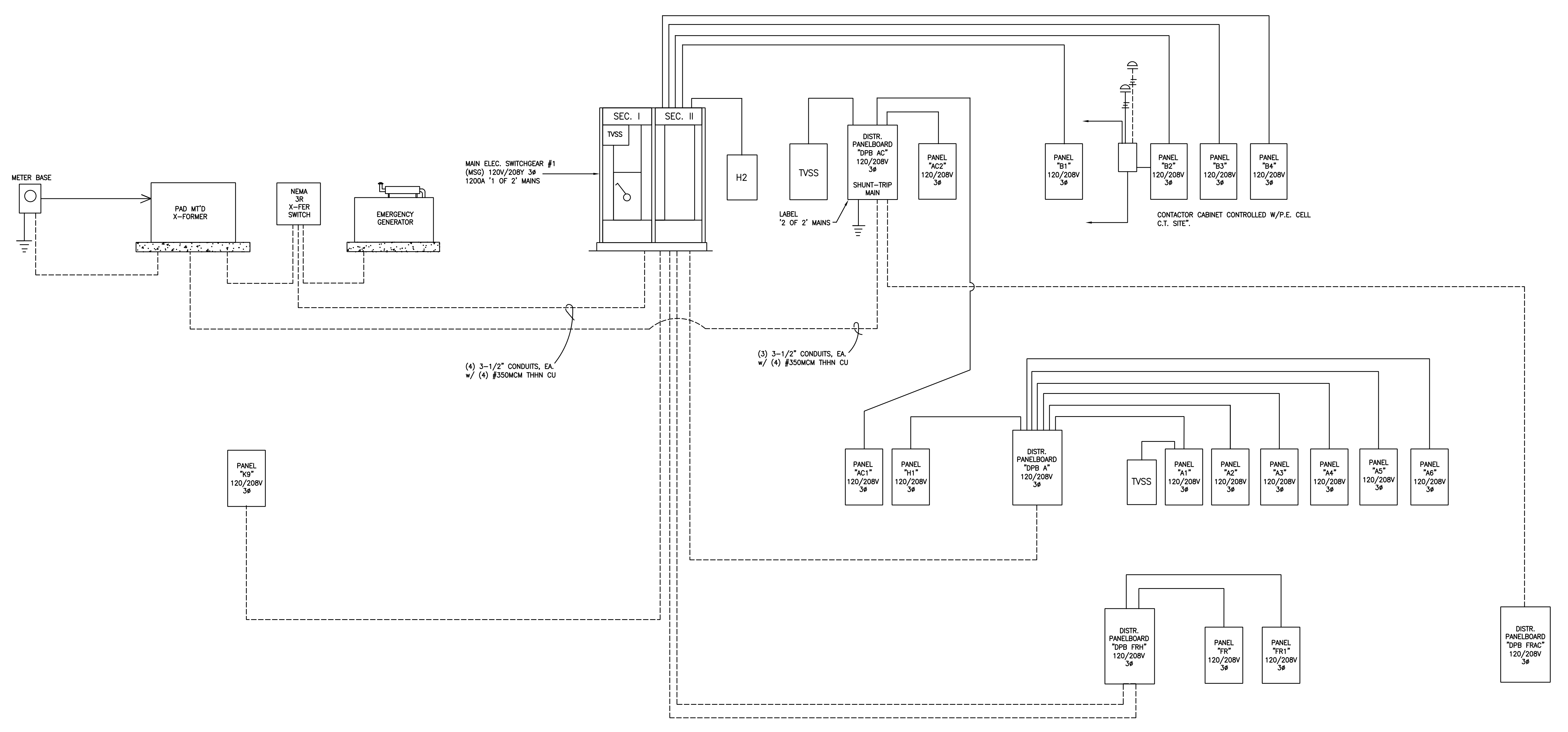
PANEL AC1												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA	A	B	C	VA	A				B
ROOF TOP UNIT #11C	25	1	1,801	4,083			2,282	2	30	ROOFTOP UNIT #71C		
		3	1,801	4,083	4,083		2,282	4				
		5	1,801	4,083			2,282	6				
		7	1,801	4,203			2,402	8				
ROOF TOP UNIT #14C	25	9	1,801	4,203			2,402	10	40	ROOFTOP UNIT #81C		
		11	1,801				2,402	12				
		13	2,402	4,683			2,282	14				
		15	2,402				2,282	16				
ROOF TOP UNIT #21C	40	17	1,801	4,203			2,402	18	35	ROOFTOP UNIT #91C		
		19	1,801				2,402	20				
ROOF TOP UNIT #31C	25	21	1,801	4,203			2,402	22	40	ROOFTOP UNIT #101C		
		23	1,801				2,402	24				
		25	3,723	7,526			4,203	26				
		27	3,723				4,203	28				
ROOF TOP UNIT #41C	60	29	1,801	7,526			4,203	30	50	ROOFTOP UNIT #111C		
		31	1,801				4,203	32				
		33	1,801	1,801			1,801	34	20	SPARE		
		35	1,801				1,801	36				
		37	2,282	2,282			2,282	38				
		39	2,282				2,282	40				
ROOF TOP UNIT #61C	35	41	2,282				2,282	42	30	SPARE		
		43	2,282				2,282	44				
CONN. LOAD (PHASE VA)			29,182	29,182	29,182		20,938					
CONN. LOAD (PHASE AMPS)			243.2	243.2	243.2		174.5					
TOTAL CONNECTED			87.5 kVA			63.3 kVA						
TOTAL AMPS			243.0 AMPS			174.8 AMPS						
TOTAL DEMAND			243.0 AMPS			174.8 AMPS						

PANEL AC2												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA	A	B	C	VA	A				B
ROOF TOP UNIT #12C	50	1	3,326	3,326			0	2		SPARE		
		3	3,326				3,326	0	4			
		5	3,326				3,326	0	6			
		7	4,948	4,948			0	8				
ROOF TOP UNIT #13C	60	9	4,948				4,948	0	10	SPARE		
		11	4,948				4,948	0	12			
		13	1,561	1,561			0	14				
		15	1,561				1,561	0	16			
ROOF TOP UNIT #14C	30	17	1,561				1,561	0	18	SPARE		
		19	1,560	1,560			0	20				
		21	1,560				1,560	0	22			
ROOF TOP UNIT #15C	20	23	1,040				1,040	0	24	SPARE		
		25	1,040				1,040	0	26			
ROOF TOP UNIT #16C	20	27	4,635	4,635			0	28				
		29	4,635				4,635	0	30	SPARE		
ROOF TOP UNIT #17C	60	31	4,635	4,635			0	32				
		33	3,867				3,867	0	34	SPARE		
		35	3,867				3,867	0	36			
ROOF TOP UNIT #18C	50	37	3,867	3,867			0	38				
		39	1,560				1,560	0	40	SPARE		
ROOF TOP UNIT #19C	30	41	1,560				1,560	0	42			
CONN. LOAD (PHASE VA)			20,938	21,458	20,938		174.5					
CONN. LOAD (PHASE AMPS)			174.5	176.8	174.5		127.5					
TOTAL CONNECTED			63.3 kVA			44.1 kVA						
TOTAL AMPS			174.8 AMPS			127.5 AMPS						
TOTAL DEMAND			174.8 AMPS			127.5 AMPS						

PANEL H1												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA	A	B	C	VA	A				B
ROOF TOP UNIT #11F	20	1	1,429	3,026			1,429	2		ROOF TOP UNIT #7F		
		3	1,429				3,026	4				
		5	1,429				3,026	6				
		7	1,429	3,026			1,429	8				
ROOF TOP UNIT #14F	20	9	1,429	3,026			1,429	10	20	ROOF TOP UNIT #6F		
		11	1,429				3,026	12				
		13	1,429	2,858			1,429	14				
		15	1,429				2,858	16				
ROOF TOP UNIT #21F	20	17	1,429	2,858			1,429	18	20	ROOF TOP UNIT #9F		
		19	1,429				2,858	20				
ROOF TOP UNIT #31F	20	21	1,429	2,858			1,429	22	20	ROOF TOP UNIT #10F		
		23	1,429				2,858	24				
		25	1,597	3,603			2,005	26				
		27	1,597				3,603	28				
ROOF TOP UNIT #41F	20	29	1,429	1,429			0	30	20	SPARE		
		31	1,429				1,429	32				
		33	1,429				1,429	34	20	SPARE		
		35	1,429				1,429	36	20	SPARE		
ROOF TOP UNIT #51F	20	37	1,429	1,429			0	38				
		39	1,429				1,429	40				
ROOF TOP UNIT #61F	20	41	1,429				1,429	42				
CONN. LOAD (PHASE VA)			18,229	18,229	18,229		10,388					
CONN. LOAD (PHASE AMPS)			151.9	151.9	151.9		85.6					
TOTAL CONNECTED			54.1 kVA			31.6 kVA						
TOTAL AMPS			151.8 AMPS			85.3 AMPS						

PANEL H2												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA	A	B	C	VA	A				B
ROOF TOP UNIT #12F	20	1	1,429	1,429			0	2		SPARE		
		3	1,429				1,429	0	4			
		5	1,429				1,429	0	6			
		7	2,005	2,005			1,429	0	8			
		9	2,005				2,005	0	10	20	SPARE	
		11	2,005				2,005	0	12			
ROOF TOP UNIT #13F	20	13	1,429	1,429			1,429	0	14	20	SPARE	
		15	1,429				1,429	0	16			
ROOF TOP UNIT #14F	20	17	1,429				1,429	0	18	20	SPARE	
		19	1,429				1,429	0	20			
ROOF TOP UNIT #15F	20	21	1,310	1,310			1,310	0	22	20	SPARE	
		23	1,019				1,019	0	24			
ROOF TOP UNIT #16F	20	25	1,019	1,019			0	26	20	SPARE		
		27	1,597				1,597	0	28	20	SPARE	
		29	1,597				1,597	0	30	20	SPARE	
ROOF TOP UNIT #17F	20	31	1,597	1,597			0	32	20	SPARE		
		33	1,597				1,597	0	34	20	SPARE	
		35	1,597				1,597	0	36	20	SPARE	
ROOF TOP UNIT #18F	20	37	1,597	1,597			0	38		SPARE		
		39	1,310				1,310	0	40		SPARE	
ROOF TOP UNIT #15F	20	41	1,310				1,310	0	42		SPARE	
CONN. LOAD (PHASE VA)			10,388	10,379	10,388		59.6					
CONN. LOAD (PHASE AMPS)			85.6	85.0	85.6		50.8					
TOTAL CONNECTED			31.6 kVA			18.8 kVA						
TOTAL AMPS			85.3 AMPS			49.3 AMPS						

EXISTING PANEL SCHEDULES (FOR REFERENCE ONLY)



EXISTING 1200A, 120V/208Y, 4W SINGLE-LINE DIAGRAM
NO SCALE

REVISIONS:
PROJECT: BOONE COUNTY PUBLIC SAFETY CAMPUS
BOONE COUNTY SHERIFF
3000 CONRAD LANE
BURLINGTON, KY, 41005
SHEET TITLE: EXISTING ELECTRICAL SINGLE-LINE & SCHEDULES

DRN:	CHK:	CAD REF:
07-05-19	SMG	14618E-1
DATE:	JOB NO.	
07-05-19	14618	
SHEET No.:	E-2.0	

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ISSUED OR BIDDING



PANEL AC1												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA		VA		VA					
			A	B	C	A	B	C				
ROOFTOP UNIT #1/C	25	1	1,801	4,083			2,282	2		ROOFTOP UNIT #7/C		
		3	1,801	4,083	4,083	2,282	4					
		5	1,801		4,083	2,282	6					
		7	1,801	4,203		2,402	8					
ROOFTOP UNIT #1/A/C	25	9	1,801	4,203	4,203	2,402	10		40	ROOFTOP UNIT #8/C		
		11	1,801		4,203	2,402	12					
		13	2,402	4,683		2,282	14					
ROOFTOP UNIT #2/C	40	15	2,402	4,683	4,683	2,282	16		35	ROOFTOP UNIT #9/C		
		17	2,402		4,683	2,282	18					
		19	1,801	4,203		2,402	20					
ROOFTOP UNIT #3/C	25	21	1,801	4,203	4,203	2,402	22		40	ROOFTOP UNIT #10/C		
		23	1,801		4,203	2,402	24					
		25	3,723	7,926		4,203	26					
ROOFTOP UNIT #4/C	60	27	3,723	7,926	7,926	4,203	28		50	ROOFTOP UNIT #11/C		
		29	3,723		7,926	4,203	30					
		31	1,801	1,801			32					
ROOFTOP UNIT #5/C	25	33	1,801	1,801	1,801		34		20	SPARE		
		35	1,801		1,801		36					
		37	2,282	2,282			38					
ROOFTOP UNIT #6/C	35	39	2,282	2,282	2,282		40		30	SPARE		
		41	2,282		2,282		42					
CONN. LOAD (PHASE VA)			28,182	28,182	28,182							
CONN. LOAD (PHASE AMPS)			243.2	243.2	243.2							
TOTAL CONNECTED:			87.5 kVA									
TOTAL AMPS:			243.0 AMPS									
TOTAL DEMAND:			243.0 AMPS									

PANEL AC2												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA		VA		VA					
			A	B	C	A	B	C				
ROOFTOP UNIT #12/C	40	1	2,402	2,402			0	2		SPACE		
		3	2,402	2,402	2,402	0	4			SPACE		
		5	2,402		2,402	0	6			SPACE		
		7	3,723	3,723			0	8		SPACE		
ROOFTOP UNIT #13/C	60	9	3,723	3,723	3,723		0	10		SPACE		
		11	3,723		3,723	0	12			SPACE		
		13	1,801	1,801			0	14		SPACE		
ROOFTOP UNIT #14/C	25	15	1,801	1,801	1,801		0	16		SPACE		
		17	1,801		1,801	0	18			SPACE		
		19	1,560	1,560			0	20		SPACE		
ROOFTOP UNIT #15/C	25	21	1,560	1,560	1,560		0	22		SPACE		
		23	0	0	0	0	24			SPACE		
SPACE	20	25	0	0	0	0	26			SPACE		
		27	2,402	2,402	2,402	0	28		20	SPACE		
		29	2,402		2,402	0	30			SPACE		
		31	2,402	2,402			0	32		SPACE		
ROOFTOP UNIT #17/C	40	33	2,402	2,402	2,402		0	34		SPACE		
		35	2,402		2,402	0	36			SPACE		
		37	2,402	2,402			0	38		SPACE		
ROOFTOP UNIT #18/C	40	39	2,402	2,402	2,402		0	40		SPACE		
		41	1,560	1,560	1,560		0	42		SPACE		
CONN. LOAD (PHASE VA)			14,289	15,849	14,289							
CONN. LOAD (PHASE AMPS)			119.1	132.1	119.1							
TOTAL CONNECTED:			44.4 kVA									
TOTAL AMPS:			123.3 AMPS									
TOTAL DEMAND:			123.3 AMPS									

PANEL H1												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA		VA		VA					
			A	B	C	A	B	C				
ROOFTOP UNIT #1/F	15	1	721	1,681			961	2		ROOFTOP UNIT #7/F		
		3	721	1,681	1,681	961	4					
		5	721		1,681	961	6					
		7	721	1,801		1,081	8					
ROOFTOP UNIT #1/A/F	15	9	721	1,801	1,801	1,081	10		15	ROOFTOP UNIT #8/F		
		11	721		1,801	1,081	12					
		13	1,081	2,162		1,081	14					
ROOFTOP UNIT #2/F	15	15	1,081	2,162	2,162	1,081	16		15	ROOFTOP UNIT #9/F		
		17	1,081		2,162	1,081	18					
		19	1,561	2,642		1,081	20					
ROOFTOP UNIT #3/F	20	21	1,561	2,642	2,642	1,081	22		15	ROOFTOP UNIT #10/F		
		23	1,561		2,642	1,081	24					
		25	2,642	4,563		1,921	26					
ROOFTOP UNIT #4/F	35	27	2,642	4,563	4,563	1,921	28		25	ROOFTOP UNIT #11/F		
		29	2,642		4,563	1,921	30					
		31	721	721			32		20	SPARE		
ROOFTOP UNIT #5/F	15	33	721	721	721		34		20	SPARE		
		35	721		721		36		20	SPARE		
		37	721	721			38			SPACE		
ROOFTOP UNIT #6/F	15	39	721	721	721		40			SPACE		
		41	721		721		42			SPACE		
CONN. LOAD (PHASE VA)			14,291	14,291	14,291							
CONN. LOAD (PHASE AMPS)			119.1	119.1	119.1							
TOTAL CONNECTED:			42.9 kVA									
TOTAL AMPS:			119.0 AMPS									
TOTAL DEMAND:			119.0 AMPS									

PANEL H2												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE						C K T	T R I P	DESCRIPTION LOAD	
			VA		VA		VA					
			A	B	C	A	B	C				
ROOFTOP UNIT #12/F	15	1	961	961			0	2		SPARE		
		3	961	961	961	0	4			SPARE		
		5	961		961	0	6			SPARE		
		7	2,282	2,282	2,282	0	8			SPARE		
ROOFTOP UNIT #13/F	30	9	2,282	2,282	2,282	0	10		20	SPARE		
		11	2,282		2,282	0	12			SPARE		
		13	721	721			0	14				
ROOFTOP UNIT #14/F	15	15	721	721	721		0	16	20	SPARE		
		17	721		721	0	18			SPARE		
		19	624	624			0	20		SPACE		
ROOFTOP UNIT #15/F	15	21	624	624	624		0	22	20	SPACE		
		23	0	0	0	0	24			SPACE		
SPACE	15	25	0	0	0	0	26		20	SPACE		
		27	1,081		1,081		0	28	20	SPACE		
		29	1,081		1,081		0	30	20	SPACE		
		31	1,081	1,081			0	32	20	SPACE		
ROOFTOP UNIT #17/F	15	33	961	961	961		0	34	20	SPACE		
		35	961		961		0	36	20	SPACE		
		37	961	961			0	38		SPACE		
ROOFTOP UNIT #18/F	15	39	624	624	624		0	40		SPACE		
		41	624		624		0	42		SPACE		
CONN. LOAD (PHASE VA)			6,628	7,252	6,628							
CONN. LOAD (PHASE AMPS)			55.2	60.4	55.2							
TOTAL CONNECTED:			20.8 kVA									
TOTAL AMPS:			56.9 AMPS									
TOTAL DEMAND:			56.9 AMPS									

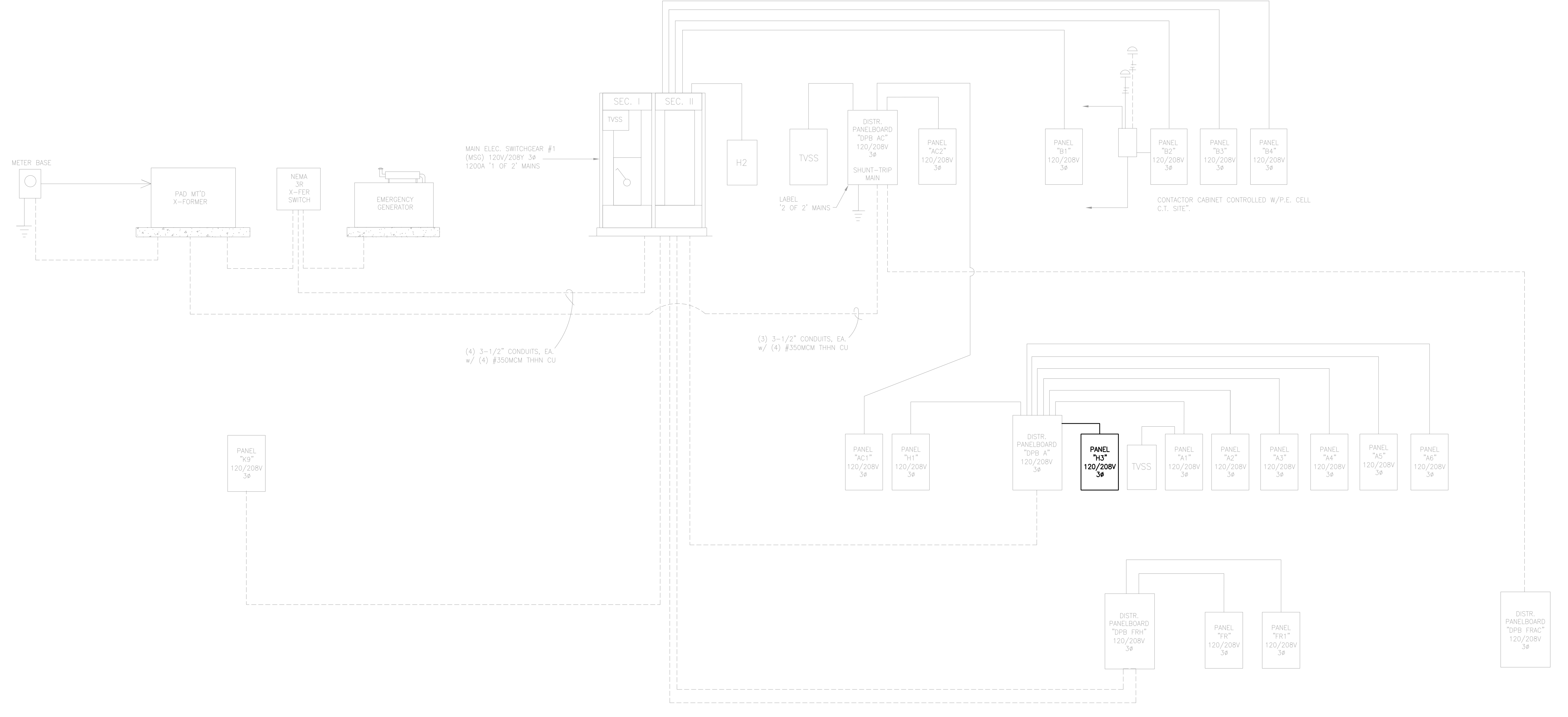
LOAD CALCULATION
PANEL AC1
 LIGHTING @ 125%: 0.0 kVA
 RECEIPTS: 0.0 kVA
 FIRST 10kVA @ 100%: 0.0 kVA
 REMAINDER @ 50%: 0.0 kVA
 MOTORS @ 100%: 0.0 kVA
 LARGEST MOTOR + 25%: 0.0 kVA
 HVAC @ 100%: 0.0 kVA
 COOLING @ 100%: 87.5 kVA
 HEATING @ 100%: 0.0 kVA
 KITCHEN @ 0%: 0.0 kVA
 MISC @ 100%: 0.0 kVA
 MISC @ 125%: 0.0 kVA
87.5 kVA
243.0 AMPS

LOAD CALCULATION
PANEL AC2
 LIGHTING @ 125%: 0.0 kVA
 RECEIPTS: 0.0 kVA
 FIRST 10kVA @ 100%: 0.0 kVA
 REMAINDER @ 50%: 0.0 kVA
 MOTORS @ 100%: 0.0 kVA
 LARGEST MOTOR + 25%: 0.0 kVA
 HVAC @ 100%: 0.0 kVA
 COOLING @ 100%: 44.4 kVA
 HEATING @ 100%: 0.0 kVA
 KITCHEN @ 0%: 0.0 kVA
 MISC @ 100%: 0.0 kVA
 MISC @ 125%: 0.0 kVA
44.4 kVA
123.3 AMPS

LOAD CALCULATION
PANEL H1
 LIGHTING @ 125%: 0.0 kVA
 RECEIPTS: 0.0 kVA
 FIRST 10kVA @ 100%: 0.0 kVA
 REMAINDER @ 50%: 0.0 kVA
 MOTORS @ 100%: 0.0 kVA
 LARGEST MOTOR + 25%: 0.0 kVA
 HVAC @ 100%: 0.0 kVA
 COOLING @ 100%: 42.9 kVA
 HEATING @ 100%: 0.0 kVA
 KITCHEN @ 0%: 0.0 kVA
 MISC @ 100%: 0.0 kVA
 MISC @ 125%: 0.0 kVA
42.9 kVA
119.0 AMPS

LOAD CALCULATION
PANEL H2
 LIGHTING @ 125%: 0.0 kVA
 RECEIPTS: 0.0 kVA
 FIRST 10kVA @ 100%: 0.0 kVA
 REMAINDER @ 50%: 0.0 kVA
 MOTORS @ 100%: 0.0 kVA
 LARGEST MOTOR + 25%: 0.0 kVA
 HVAC @ 100%: 0.0 kVA
 COOLING @ 100%: 20.5 kVA
 HEATING @ 100%: 0.0 kVA
 KITCHEN @ 0%: 0.0 kVA
 MISC @ 100%: 0.0 kVA
 MISC @ 125%: 0.0 kVA
20.5 kVA
56.9 AMPS

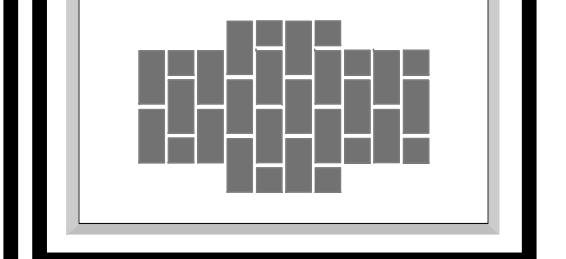
REVISED PANEL SCHEDULES



REVISED 1200A, 120V/208Y, 4W SINGLE-LINE DIAGRAM
NO SCALE

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HAL-PE ASSOCIATES
 ENGINEERING SERVICES, INC.
 530 W. 9TH ST.
 NEWPORT, KY 41071
 859.431.6083
 halpe.com



REVISIONS:

PROJECT: BOONE COUNTY PUBLIC SAFETY CAMPUS
 BOONE COUNTY SHERIFF
 3000 CONRAD LANE
 BURLINGTON, KY 41005

SHEET TITLE: REVISED ELECTRICAL SINGLE-LINE & SCHEDULES

DRN: CHK: CAD REF:
 DRG SMG 14618E-1

DATE: JOB NO.
 07-05-19 14618

SHEET No.:
E-2.1

ISSUED FOR BIDDING



PANEL H3												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE				C K T	T R I P	DESCRIPTION LOAD	T R I P	C K T	DESCRIPTION LOAD
			VA	A	B	C						
WV-2-1	15	3	1,000	2,000	2,000	1,000	2	WV-5-4				
WV-2-2	15	5	1,000		1,750	750	8	WV-5-5				
WV-2-3	20	9	2,000		3,000	1,000	10	WV-10-2				
WV-2-4	20	11	2,000		3,000	1,000	12	WV-10-3 & WV-10-4				
WV-2-5 & WV-2-6	20	13	1,500	3,000		1,500	14	WV-10-5 & WV-10-6				
WV-3-1 & WV-3-2	20	17	1,625		2,750	1,125	18	WV-14-1 & WV-14-2				
WV-3-3 & WV-3-4	20	21	1,500		3,000	1,500	22	WV-14-3 & WV-14-4 & WV-14-5				
WV-3-5 & WV-3-6	20	23	1,500		3,000	1,500	24					
WV-4-1 & WV-4-2	20	25	1,500	2,250		750	26	WV-18-1				
WV-4-3	20	27	1,500		3,000	1,500	28	WV-18-2				
WV-4-4	25	29	750		2,000	1,250	30	WV-18-3				
WV-4-5	20	31	750	2,000		1,250	32	WV-18-4				
WV-4-6 & WV-4-7	20	33	1,500		4,000	2,500	34					
WV-5-1 & WV-5-2	20	35	1,500		4,000	2,500	36					
WV-5-3	20	37	1,500	2,250		750	38					
SPACE	--	39	1,500		2,250	750	40					
SPACE	--	41	2,000		3,500	1,500	42					
SPACE	--	43	2,000	3,500		1,500	44					
SPACE	--	45	2,000		2,000	0	46					
SPACE	--	47	2,000		2,000	0	48					
SPACE	--	49	1,250	1,250		0	50					
SPACE	--	51	1,250		1,250	0	52					
SPACE	--	53	1,625		1,625	0	54					
SPACE	--	55	1,625	1,625		0	56					
SPACE	--	57	1,000		1,000	0	58					
SPACE	--	59	1,000		1,000	0	60					
SPACE	--	61	0	0	0	0	62					
SPACE	--	63	0	0	0	0	64					
SPACE	--	65	0	0	0	0	66					
SPACE	--	67	0	0	0	0	68					
SPACE	--	69	0	0	0	0	70					
SPACE	--	71	0	0	0	0	72					
SPACE	--	73	0	0	0	0	74					
SPACE	--	75	0	0	0	0	76					
SPACE	--	77	0	0	0	0	78					
SPACE	--	79	0	0	0	0	80					
SPACE	--	81	0	0	0	0	82					
SPACE	--	83	0	0	0	0	84					
CONN. LOAD (PHASE) (VA)			23,125	24,500	24,625							
TOTAL CONNECTED:			72.3 KVA									
TOTAL AMPS:			280.5 AMPS									
TOTAL DEMAND:			152.4 AMPS									
SOURCE:			MSG									
VOLTAGE:			120/208V, 3PH, 4W									
FEEDER:			SEE RISER DIAGRAM									
MOUNTING:			SURFACE									
AIC:												

DPB A												
DESCRIPTION LOAD	T R I P	C K T	VA PER PHASE				C K T	T R I P	DESCRIPTION LOAD	T R I P	C K T	DESCRIPTION LOAD
			VA	A	B	C						
SPACE	--	1	0	0	0	0	2	SPACE				
SPACE	--	3	0	0	0	0	4	SPACE				
SPACE	--	5	0	0	0	0	6	SPACE				
SPACE	--	7	23,125	23,125				SPACE				
PANEL H3	225	9	24,500		24,500	0	8	SPACE				
SPACE	--	11	24,625		24,625	0	12	SPACE				
SPACE	--	13	0	9,247		9,247		SPACE				
SPACE	--	15	0	9,247		9,247	16	PANEL A1 (DESIGN LOAD)				
SPACE	--	17	0		9,247	9,247	18	SPACE				
PANEL H1	--	19	14,291	21,256		6,965	20	PANEL A2 (DESIGN LOAD)				
SPACE	--	21	14,291		21,256	6,965	22	SPACE				
SPACE	--	23	14,291		21,256	6,965	24	SPACE				
PANEL A5 (DESIGN LOAD)	--	25	8,646	16,933		8,286	26	PANEL A3 (DESIGN LOAD)				
SPACE	--	27	8,646		16,933	8,286	28	SPACE				
SPACE	--	29	8,646		16,933	8,286	30	SPACE				
PANEL A6 (DESIGN LOAD)	--	31	11,649	16,572		4,924	32	PANEL A4 (DESIGN LOAD)				
SPACE	--	33	11,649		16,572	4,924	34	SPACE				
SPACE	--	35	11,649		16,572	4,924	36	SPACE				
CONN. LOAD (PHASE) (VA)			87,132	88,507	88,632							
TOTAL CONNECTED:			264.3 KVA									
TOTAL AMPS:			733.6 AMPS									
TOTAL DEMAND:			564.4 AMPS									
SOURCE:			MSG									
VOLTAGE:			120/208V, 3PH, 4W									
FEEDER:			SEE RISER DIAGRAM									
MOUNTING:			SURFACE									
AIC:												

LOAD CALCULATIONS

EXISTING DPB A DESIGN LOAD: 221.4 KVA
 NEW DPB A DESIGN LOAD: 203.3 KVA
 NET GAIN (LOSS): (18.1) KVA (50.2) AMPS

EXISTING PANEL AC1 DESIGN LOAD: 107.0 KVA
 NEW PANEL AC1 DESIGN LOAD: 87.5 KVA
 NET GAIN (LOSS): (19.5) KVA (54.1) AMPS

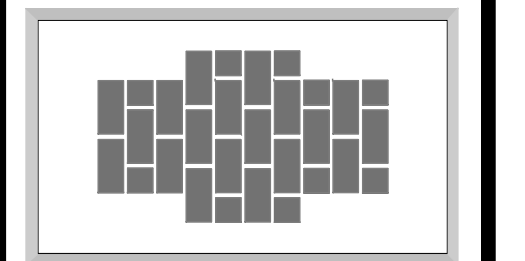
EXISTING PANEL AC2 DESIGN LOAD: 59.8 KVA
 NEW PANEL AC2 DESIGN LOAD: 47.5 KVA
 NET GAIN (LOSS): (12.3) KVA (34.1) AMPS

NOTE: ALL EXISTING PANELS ARE TO HAVE A NET REDUCTION IN POWER USAGE AS A RESULT OF THIS SCOPE OF WORK.

LOAD CALCULATION				LOAD CALCULATION			
PANEL H3				DPB A			
SPACE	--	65	0	0.0 KVA	RECEPTS @ 125%:		0.0 KVA
SPACE	--	67	0	0.0 KVA	FIRST 10KVA @ 100%:		0.0 KVA
SPACE	--	69	0	0.0 KVA	REMAINDER @ 50%:		0.0 KVA
SPACE	--	71	0	0.0 KVA	MOTORS @ 100%:		0.0 KVA
SPACE	--	73	0	0.0 KVA	LARGEST MOTOR + 25%:		0.0 KVA
SPACE	--	75	0	0.0 KVA	HVAC @ 100%:		0.0 KVA
SPACE	--	77	0	0.0 KVA	COOLING @ 100%:	0	0.0 KVA
SPACE	--	79	0	0.0 KVA	HEATING @ 75%:	54.2	54.2 KVA
SPACE	--	81	0	0.0 KVA	MISC @ 100%:	0.0 KVA	0.0 KVA
SPACE	--	83	0	0.0 KVA	MISC @ 125%:	0.0 KVA	0.0 KVA
KITCHEN @ 0%:				0.0 KVA	KITCHEN @ 0%:		
MISC @ 100%:				0.0 KVA	MISC @ 100%:		
MISC @ 125%:				0.0 KVA	MISC @ 125%:		
TOTAL:				54.2 KVA	TOTAL:		
TOTAL AMPS:				150.4 AMPS	TOTAL AMPS:		

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HAL-PE ASSOCIATES
 ENGINEERING SERVICES, INC.
 530 W. 9TH ST.
 NEWPORT, KY 41071
 859.431.6083
 halpe.com



REVISIONS:

PROJECT: BOONE COUNTY PUBLIC SAFETY CAMPUS
 BOONE COUNTY SHERIFF
 3000 CONRAD LANE
 BURLINGTON, KY, 41005

SHEET TITLE: ELECTRICAL SCHEDULES & CALCULATIONS

DRN: CHK: CAD REF:
 DRG SMG 14618E-1

DATE: JOB NO.
 07-05-19 14618

SHEET No.:
E-2.2

ISSUED FOR BIDDING



QUESTION & ANSWER No. 1

August 15, 2019

Boone County Fiscal Court

RFP # 08022019SHVAC – HVAC REPLACEMENT FOR THE BOONE COUNTY SHERIFF'S OFFICE

The information in this question and answer posting is intended to provide guidance related to questions that Boone County received from the public. None of the information provided is intended to supersede any section of the original solicitation.

Acknowledge receipt of this document by attaching this sheet to the last page of the bid form. Failure to do so, may subject the bidder to disqualification. This question and answer document forms a part of the contract documents.

Q1: Does any roofing contractor have a warranty on the roof?

A1: No warranty on the roof.

Q2: What are the hours available to work on this project?

A2: Sheriff's department is operational from 7:30 a.m. to 4:30 p.m.. All work on this project should be planned to fit into the Sheriff's operational hours unless an agreement can be reached between the awarded contractor and Sheriff.

Q3: Page 9 states shut downs can only be for one day, can you elaborate?

A3: The building will be occupied during construction. Length of shutdowns should be minimized. Contractor can develop a schedule for shut downs. The shutdown schedule and any changes should be shared with the Sheriff for planning/scheduling purposes.

Q4: What type of material is to be used for the condensate piping?

A4: PVC

Q5: Is there a detail for the condensate lines?

A5: The condensate lines should be ran from the RTU and piped to spill onto the roof.

Q6: Is this a prevailing wage job?

A6: No.



Q7: *Is the project taxable?*

A7: *Boone County, Kentucky is a Governmental Entity, exempt from sales tax on the purchase of products or services. Contractors paying sales tax on products and services are allowed to pass those costs on as part of the total project cost.*

Q8: *Who replaces ceiling tiles after the demo of ceiling radiant heaters?*

A8: *Boone County Property Maintenance will provide the contractor with replacement ceiling tiles to be utilized as the project proceeds.*

Q9: *Who is responsible to repair or paint areas of drywall that may be damaged during construction?*

A9: *The contract is responsible to repair any damage to drywall/walls incurred during construction. Boone County Property Maintenance will be responsible to paint repaired drywall/walls.*

Q10: *If the isolation rail on RTUs gets eliminated, is it attached to the roof flashing? Can you elaborate?*

A10: *The old isolation rail must be removed. Most RTUs have an isolation rail as part of the installation set. The new isolation rail must be installed on a new curb adapter if needed or onto the existing curb if the unit is using the existing curb.*

Q11: *Aaon is stating a 17 week lead time on delivery. How does this lead time fit into the project schedule?*

A11: *Please list any manufacturer delivery restrictions as an exception to the proposed "Fall of 2019" project start timeframe in the proposal.*

Q12: *Factory or Field installed RTU controllers, what is the County's preference?*

A12: *Boone County does have a preference on when the controllers are installed. The County does prefer that the component utilized by the vendor be obtainable from multiple vendors/sources.*

Q13: *Regarding the shooting range AHU and exhaust fan; what is currently controlling them and or if we need to replace the controller, can we get a picture of the AHU and its current controls (i.e., SF, DX, Economizer Dampers ect.)?*

A13: *The shooting range is currently operating on a standalone system. Due to the conditions/activities inside the building, there will be no work scheduled for that building.*

Q14: *There was a question regarding notes on DWG M-4.1 regarding the existing controls. The first note states "Existing HVAC equipment that will not be effected as part of the new work shall maintain their control functions on the new BAS". What all existing equipment is that and what are the current controls on that equipment?*

A14: *See note 6 on M1.0.*

GARY W. MOORE
COUNTY JUDGE/EXECUTIVE



BOONE COUNTY
FINANCE DEPARTMENT

BOONECOUNTYKY.ORG

BENJAMIN T. REECE, CPA
COUNTY TREASURER

Bidder Acknowledges receipt of Question & Answer No. 1.

By: _____ Signature

_____ Title

_____ Date