

ADVERTISEMENT FOR BIDS

Sealed proposals will be received in the Office of the Procurement Manager, Greenville Utilities Commission, 401 S. Greene Street, Greenville, North Carolina 27834 until 2:00 PM (EDT) on April 24, 2025 and immediately thereafter publicly opened and read for the furnishing of Installation of HVAC Upgrade for Administration Building.

Instructions for submitting bids and complete specifications will be available in the Office of the Procurement Manager, Greenville Utilities Commission, 401 S. Greene Street, Greenville, North Carolina during regular office hours, which are 8:30AM – 5:00PM Monday through Friday.

Greenville Utilities Commission reserves the right to reject any or all bids. **Late bids will not be considered.**

PRE-BID MEETING – A Pre-Bid meeting will be held at Greenville Utilities Commission, Administration Building, 401 S. Greene St., Greenville, North Carolina 27834 on Thursday, April 10, 2025 at 9:00 am (EDT).

The intent of the Pre-Bid Meeting is to allow the bidders an opportunity to ask questions and make clarifications prior to submitting a bid.

A site walkthrough will be performed during the April 10th Pre-Bid meeting. Only portions of the bid/contract will be discussed. Lack of discussion or clarification of any portion of the bid/contract does not relieve the Bidder from conforming to the provisions of the same.

Questions regarding this Request for Bid (RFB) should be received by or before 5:00pm, April 14, 2025. All questions shall be directed via e-mail to the attention of Cleve Haddock, Lifetime CLGPO, Procurement Manager at: haddocgc@guc.com, (252) 551-1533.

SECTION I
GENERAL INSTRUCTIONS FOR FORMAL BIDS
RELATED TO THE PURCHASE OF APPARATUS, SUPPLIES,
MATERIALS, AND EQUIPMENT

1.0 NOTICE TO BIDDERS

Sealed bids, subject to the conditions made a part hereof, will be received in the Office of the Procurement Manager, Greenville Utilities Commission, 401 S. Greene Street, Greenville, North Carolina 27834 until 2:00 PM (EDT) on April 24, 2025, the day of opening. **Bids submitted in a fax or e-mail in response to this Invitation for Bids will not be acceptable. Late Bids will not be considered.**

2.0 STANDARD FORMS REQUIRED

Each bidder must submit a proposal on the enclosed bid forms. **The bid must be signed by an authorized official of the firm. Return only the attached Proposal Form. Do not return the Advertisement for Bids, Instructions to Bidders or Specifications.**

3.0 PREPARATION OF BID

Bids must be in sealed envelopes clearly marked on the outside with the name of the bid and the bid opening date and time. Bid shall be addressed to the Procurement Manager, GREENVILLE UTILITIES COMMISSION, 401 S. GREENE STREET, GREENVILLE, NORTH CAROLINA 27835-1847.

4.0 TIME FOR OPENING BIDS

Bids will be opened promptly and read at the hour and on the date set forth in the advertisement in the Office of the Procurement Manager, Greenville Utilities Main Office, 401 S. Greene Street, Greenville, North Carolina. Bidders or their authorized agents are invited to be present.

5.0 DEPOSIT

A deposit is required for this bid.

6.0 NC SALES TAX

Do **not** include NC sales taxes in bid figure; however, Greenville Utilities Commission (GUC) does pay sales tax. Sales tax should be added to the invoice as a separate item.

7.0 FEDERAL EXCISE TAX

GUC is exempt from Federal Excise Tax and will issue a Federal Exemption Certificate upon request to the successful bidder.

8.0 EXCEPTIONS TO BE CLEARLY STATED

If bid is not in strict accordance with Section II, "Specifications," bidder must list or note all exceptions **on the Request for Proposal Form**, otherwise, it is fully understood that the successful bidder will furnish equipment and/or materials exactly as specified. GUC reserves the right to accept or reject bids with noted minor deviations from specifications and to determine the lowest responsible, responsive bid from the standpoint of quality, performance, and price.

9.0 EVALUATION AND AWARD OF BIDS

GUC reserves the right to reject any and all bids, to waive any and all informalities, and to disregard all nonconforming or conditional bids or counter proposals. In evaluating bids, GUC shall consider whether the bids comply with the prescribed requirements, plus all alternates or options requested. GUC reserves the right to include or exclude any option or alternative in GUC's opinion is in GUC's best interests. If a bid is to be awarded, it will be awarded to the lowest responsible, responsive bidder whose evaluation by GUC indicates that the award will be in GUC's best interests. Only firm prices will be considered for award of this bid.

10.0 PROMPT PAYMENT DISCOUNTS

Bidders are urged to compute all discounts into the price offered. If a prompt payment discount is offered, it may be considered in the award of the contract.

11.0 NUMERICAL ERRORS

In the case of a discrepancy between a unit price and the extension (the unit price multiplied by the number of units), the unit price governs. In the case where numerical bids are stated both in numbers and in words, the words govern.

12.0 BID WITHDRAWAL

A bidder must notify GUC in writing of its request to withdraw a bid within seventy-two (72) hours after the bid opening, not including Saturdays, Sundays, or holidays. In order to justify withdrawal, the bidder must demonstrate that a substantial error exists and that the bid was submitted in good faith.

13.0 MINORITY BUSINESS PARTICIPATION PROGRAM

GUC has adopted an Affirmative Action and Minority and Women Business Enterprise Plan (M/WBE) Program. Firms submitting a proposal are attesting that they also have taken affirmative action to ensure equality of opportunity in all aspects of employment, and to utilize M/WBE suppliers of materials and/or labor.

14.0 QUANTITIES

Quantities specified are only estimates of GUC's requirements. GUC reserves the right to purchase more or less than the stated quantities at prices indicated in the submitted Proposal Form based on our actual needs.

15.0 DELIVERY

Shipments will be made to GUC only upon releases from a purchase order issued by GUC in accordance with its current needs.

Time is of the essence with respect to all deliveries under this Agreement.

Delivery of all equipment, materials, or supplies shall be made Free on Board (FOB), GUC Warehouse, 701 Utility Way, Greenville, North Carolina 27834, unless otherwise specified. The agreed price for such equipment, materials, or supplies shall include all costs of delivery and ownership, and risks of loss shall not be transferred from Provider to GUC until express written acceptance of delivery and inspection by GUC. Delivery hours are between 8:00 AM and 4:30 PM Monday-Friday only. **GUC's purchase order number is to be shown on the packing slip or any related documents.** GUC reserves the right to refuse or return any delivery with no purchase order number or which is damaged. GUC will not be charged a restocking fee for any delivery which is refused or returned.

16.0 DELIVERY TIME

Delivery time is to be stated and will be considered in the evaluation of bids. Failure by the successful bidder to meet quoted delivery shall be interpreted as non-compliance with these specifications and may be deemed sufficient cause for removal of the manufacturer and/or distributor from our lists as acceptable manufacturers or bidders.

17.0 CONTRACT PERIOD

TBD.

18.0 MANUFACTURER

NA.

19.0 CONTACT INFORMATION

Questions regarding this bid request should be directed to Cleve Haddock, Procurement Manager, Finance Department at (252) 551-1533, haddocgc@guc.com. **All questions must be received via e-mail by or before 5:00pm (EDT) April 14, 2025.**

20.0 TERMS AND CONDITIONS

The attached Terms and Conditions apply to all purchases made by Greenville Utilities Commission (GUC) and must be considered as part of the bid proposal.

[Balance of page left blank intentionally]

Vendor Name: _____

GREENVILLE UTILITIES COMMISSION

PROPOSAL FORM

QUOTATIONS SHOULD BE RECEIVED BY 2:00 PM ON APRIL 24, 2025. Quotations can be mailed or delivered to Cleve Haddock, Lifetime CLGPO, Procurement Manager, 401 South Greene Street, Greenville, N.C. 27834. Greenville Utilities reserves the right to reject any and all quotes that are not in GUC's best interest.

The Bidder proposes and agrees if this proposal is accepted to contract with Greenville Utilities Commission in the form of contract specified herein to furnish all necessary materials , equipment, machinery, tools, apparatus, means of transportation and labor necessary to complete the construction and renovation of the second, third, and fourth (roof) levels of the GUC Admin Building as indicated on the contract documents. The project must be complete by December 12, 2025 in full in complete accordance with the plans specifications and contract documents to full and entire satisfaction of GUC and NV5.

GUC will provide two rooftop units (RTUs) directly purchased to Contractor for installation. RTUs shall match basis of design as indicated on contract documents.

Item No.	Description	Delivery Time (Days)	\$ Price
Base Bid	Second, Third and Fourth Level Renovation		

TOTAL \$ _____

The undersigned bidder hereby declares that it has carefully examined the enclosed detailed specifications for furnishing GUC with the below listed items. The undersigned bidder further agrees, if this proposal is accepted within thirty (30) days from the date of the opening, to furnish any or all of the items upon the quoted price.

Method of Award: GUC will award this bid as a total bid.

Complete and Check All Math: It is the responsibility of the Bidder to extend unit prices and supply a total for all items.

It is certified that this proposal is made in good faith and without collusion or connection with any other person bidding on the same above listed items. It is also certified that this proposal is made in good faith and without collusion or connection with any GUC employee(s).

Certified check or cash for \$_____ or bid bond for \$_____ attached.

Firm Name _____ Phone (_____) _____

Address _____

City _____ State _____ Zip Code _____

Fax (____) _____ E-Mail _____

Authorized Official _____ Title _____
Typed Name

Signature Date _____

**One (1) Sealed Hard copy & One (1) Electronic copy of your proposal should be
received no later than
April 24, 2025 at 2:00 PM (EDT).**

NO BIDS CONSIDERED UNLESS SUBMITTED ON THIS FORM(S)

(RETURN ONLY THIS FORM(S) AND EXCEPTION, E-VERIFY)

GREENVILLE UTILITIES COMMISSION

GREENVILLE, NORTH CAROLINA

SPECIFICATION/ EXCEPTION FORM

Specifications for: Installation of HVAC Upgrade for Administration Building

Bidder's Certification: This is to certify that it is our intent to furnish equipment, material, services, etc. in absolute compliance with the bid specification except where expressly noted below.

Instructions: The following is a list of exceptions to the bidding documents and/or specifications pertaining to the furnishing of new Trailers. Bidders shall identify each exception by specification page and paragraph number on this form. The omission of exception assumes complete compliance with the Specifications.

<u>Page/Paragraph #</u>	<u>Exception/Variation</u>
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Firm Represented:

Typed Name:

Authorized Signature of Certification:

Date:

Letter of Compliance to E-Verify for Greenville Utilities Commission

1. I have submitted a bid for contract or desire to enter into a contract with the Greenville Utilities Commission;
2. As part of my duties and responsibilities pursuant to said bid and/or contract, I affirm that I am aware of and in compliance with the requirements of E-Verify, Article 2 of Chapter 64 of the North Carolina General Statutes, to include (mark which applies):
3. ____ After hiring an employee to work in the United States I verify the work authorization of said employee through E-Verify and retain the record of the verification of work authorization while the employee is employed and for one year thereafter; or
4. ____ I employ less than twenty-five (25) employees in the State of North Carolina.
5. As part of my duties and responsibilities pursuant to said bid and/or contract, I affirm that to the best of my knowledge and subcontractors employed as a part of this bid and/or contract, are in compliance with the requirements of E-Verify, Article 2 of Chapter 64 of the North Carolina General Statutes, to include (mark which applies):
6. ____ After hiring an employee to work in the United States the subcontractor verifies the work authorization of said employee through E-Verify and retains the record of the verification of work authorization while the employee is employed and for one year thereafter; or
7. ____ Employ less than twenty-five (25) employees in the State of North Carolina.
Specify subcontractor: _____

_____ (Company Name)

By: _____ (Typed Name)

_____ (Authorized Signatory)

_____ (Title)

_____ (Date)

Special Instructions to Bidders

City of Greenville/Greenville Utilities Commission Minority and/or Women Business Enterprise (M/WBE) Program

GUC Construction Guidelines and Affidavits \$100,000 and above

**City of Greenville/Greenville Utilities Commission
Minority and/or Women Business Enterprise Program**

\$100,000 and Construction Guidelines for M/WBE Participants

Policy Statement

It is the policy of the City of Greenville and Greenville Utilities Commission to provide minorities and women equal opportunity for participating in all aspects of the City's and Utilities' contracting and procurement programs, including but not limited to, construction projects, supplies and materials purchases, and professional and personal service contracts.

Goals and Good Faith Efforts

Bidders responding to this solicitation shall comply with the M/WBE program by making Good Faith Efforts to achieve the following aspiration goals for participation.

	GUC	
	MBE	WBE
Construction This Goal includes Construction Manager at Risk	7%	4%

Bidders shall submit M/WBE information with their bids on the forms provided. This information will be subject to verification by GUC prior to contract award. **As of July 1, 2009, contractors, subcontractors, suppliers, service providers, or M/WBE members of joint ventures intended to satisfy GUC M/WBE goals shall be certified by the NC Office of Historically Underutilized Businesses (NC HUB) only.** Firms qualifying as "WBE" for GUC's goals must be designated as a "women-owned business" by the HUB Office. Firms qualifying as "MBE" for GUC's goals must be certified in one of the other categories (i.e.: Black, Hispanic, Asian American, American Indian, Disabled, or Socially and Economically Disadvantaged). Those firms who are certified as both a "WBE" and "MBE" may only satisfy the "MBE" requirement. A complete database of NC HUB certified firms may be found at <http://www.doa.nc.gov/hun/>. An internal database of firms who have expressed interest to do business with the City and GUC is available at www.greenvillencmwbe.org. However, the HUB status of these firms must be verified by the HUB database. GUC shall accept NCDOT certified firms on federally funded projects only. Please note: A contractor may utilize any firm desired. However, for participation purposes, all M/WBE vendors who wish to do business as a minority, or a female must be certified by NC HUB.

The Bidder shall make good faith efforts to encourage participation of M/WBEs prior to submission of bids in order to be considered as a responsive bidder. Bidders are cautioned that even though their submittal indicates they will meet the M/WBE goal, they should document their good faith efforts and be prepared to submit this information, if requested.

The M/WBE's listed by the Contractor on the **Identification of Minority/Women Business Participation** which are determined by the GUC to be certified shall perform the work and supply the materials for which they are listed unless the Contractors receive prior authorization

from the GUC to perform the work with other forces or to obtain materials from other sources. If a contractor is proposing to perform all elements of the work with his own forces, he must be prepared to document evidence satisfactory to the owner of similar government contracts where he has self-performed.

The Contractor shall enter into and supply copies of fully executed subcontracts with each M/WBE or supply signed Letter(s) of Intent to the Project Manager after award of contract and prior to Notice to Proceed. Any amendments to subcontracts shall be submitted to the Project Manager prior to execution.

Instructions

The Bidders Shall Provide with the bid the following documentation:

- ☐ Identification of Minority/Women Business Participation
(if participation is zero, please mark zero – Blank forms will be considered nonresponsive)
- ☐ Affidavit A (if subcontracting)

OR

- ☐ Identification of Minority/Women Business Participation
(if participation is zero, please mark zero – Blank forms will be considered nonresponsive)
- ☐ Affidavit B (if self-performing; must attest that bidder does not customarily subcontract work on this type of project – includes supplies and materials)

Within 72 hours or 3 business days after notification of being the apparent low bidder who is subcontracting anything must provide the following information:

- ☐ Affidavit C (if aspirational goals are met or are exceeded)

OR

- ☐ Affidavit D (if aspirational goals are not met)

After award of contract and prior to issuance of notice to proceed:

- ☐ Letter(s) of Intent or Executed Contracts

****With each pay request, the prime contractors will submit the Proof of Payment Certification, listing payments made to M/WBE subcontractors.**

*****If a change is needed in M/WBE Participation, submit a Request to Change M/WBE Participation Form. Good Faith Efforts to substitute with another M/WBE contractor must be demonstrated.**

Minimum Compliance Requirements:

All written statements, affidavits, or intentions made by the Bidder shall become a part of the agreement between the Contractor and the GUC for performance of contracts. Failure to comply with any of these statements, affidavits or intentions or with the minority business guidelines shall constitute a breach of the contract. A finding by the GUC that any information submitted (either prior to award of the contract or during the performance of the contract) is inaccurate, false, or incomplete, shall also constitute a breach of the contract. Any such breach may result in termination of the contract in accordance with the termination provisions contained in the contract. It shall be solely at the option of the GUC whether to terminate the contract for breach or not. In determining whether a contractor has made Good Faith Efforts, the GUC will evaluate all efforts made by the Contractor and will determine compliance regarding quantity, intensity, and results of these efforts.

Identification of Minority/Women Business Participation

I, _____,
(Name of Bidder)

do hereby certify that on this project, we will use the following minority/women business enterprises as construction subcontractors, vendors, suppliers, or providers of professional services

Firm Name, Address and Phone #	Work Type	M/WBE Category

*M/WBE categories: Black, African American (**B**), Hispanic, Latino (**L**), Asian American (**A**), American Indian (**I**), Female (**F**), Socially and Economically Disadvantaged (**S**), Disabled (**D**)

If you will not be utilizing M/WBE contractors, please certify by entering “0”

The total value of MBE business contracting will be (\$) _____.

The total value of WBE business contracting will be (\$) _____.

Greenville Utilities Commission AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

Affidavit of _____
(Name of Bidder)

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

☐ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government-maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.

☐ **2 – (10 pts)** Made the construction plans, specifications and requirements available for review for review by prospective minority businesses or providing these documents to them at least 10 days before the bids are due.

☐ **3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.

☐ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.

☐ **5 – (10 pts)** Attended Prebid meetings scheduled by the public owner.

☐ **6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.

☐ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.

☐ **8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.

☐ **9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.

☐ **10 – (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the identification of Minority/Women Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d). Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority/women business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My Commission expires _____

Greenville Utilities Commission - AFFIDAVIT B - Intent to Perform Contract with Own Workforce

County of _____

Affidavit of _____
(Name of Bidder)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type of project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

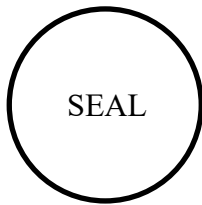
The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

Greenville Utilities Commission – AFFIDAVIT C – Portion of the Work to be Performed by M/WBE Firms

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by M/WBE businesses as defined in GS143-128.2(g) and the COG/GUC M/WBE Plan sec. III is equal to or greater than 11% of the bidder's total contract price, then the bidder must complete this affidavit. This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification.

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

(Project Name)
Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises and a minimum of _____% of the total dollar amount of the contract with women business enterprises. Minority/women businesses will be employed a construction subcontractors, vendors, suppliers, or providers of professional services. Such work will be subcontracted to the following firms listed below.

Name and Phone Number	*M/WBE Category	Work Description	Dollar Value

*M/WBE categories: Black, African American (**B**), Hispanic, Latino (**L**), Asian American (**A**), American Indian (**I**), Female (**F**), Socially and Economically Disadvantaged (**S**), Disabled (**D**)

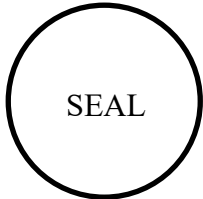
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with M/WBE Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20 _____

Notary Public _____

My commission expires _____

Greenville Utilities Commission – AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder)

If the goal of 11% participation by minority/women business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

(Project Name)
Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises and a minimum of _____% of the total dollar amount of the contract with women business enterprises. Minority/women businesses will be employed a construction subcontractors, vendors, suppliers, or providers of professional services. Such work will be subcontracted to the following firms listed below.

Name and Phone Number	*M/WBE Category	Work Description	Dollar Value

*M/WBE categories: Black, African American (**B**), Hispanic, Latino (**L**), Asian American (**A**), American Indian (**I**), Female (**F**), Socially and Economically Disadvantaged (**S**), Disabled (**D**)

Examples of documentation required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

- A. Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.
- B. Copies of quotes or responses received from each firm responding to the solicitation.

- C. A telephone log of follow-up calls to each firm sent a solicitation.
- D. For subcontracts where a minority business firm is not considered the lowest responsible, responsive sub-bidder, copies of quotes received from all firms submitting quotes for that subcontract.
- E. Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.
- F. Copy of pre-bid roster.
- G. Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.
- H. Letter detailing reasons for rejection of minority business due to lack of qualification.
- I. Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder

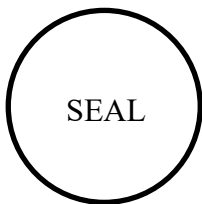
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with M/WBE Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

LETTER OF INTENT
M/WBE Subcontractor Performance

Please submit this form or executed subcontracts with M/WBE firms after award of contract and prior to issuance of notice to proceed.

PROJECT: _____
(Project Name)

TO: _____
(Name of Prime Bidder/Architect)

The undersigned intends to perform work in connection with the above project as a:

_____ Minority Business Enterprise _____ Women Business Enterprise

The M/WBE status of the undersigned is certified by the NC Office of Historically Underutilized Businesses (required). _____ Yes _____ No

The Undersigned is prepared to perform the following described work or provide materials or services in connection with the above project at the following dollar amount:

Work/Materials/Service Provided	Dollar Amount of Contract	Projected Start Date	Projected End Date

(Date)

(Address)

(Name & Phone No. of M/WBE Firm)

(Name & Title of Authorized Representative of M/WBE)

(Signature of Authorized Representative of M/WBE)

REQUEST TO CHANGE M/WBE PARTICIPATION

Submit changes only if notified as apparent lowest bidder, continuing through project completion)

Project: _____

Bidder or Prime Contractor: _____

Name & Title of Authorized Representative: _____

Address: _____ **Phone #:** _____

_____ **Email Address:** _____

Total Contract Amount (including approved change orders or amendments): \$ _____

Name of Subcontractor: _____

Good or service provided: _____

Proposed Action:

_____ Replace subcontractor

_____ Perform work with own forces

For the above actions, you must provide one of the following reasons (Please check applicable reason):

_____ The listed MBE/WBE, after having had a reasonable opportunity to do so, fails or refuses to execute a written contract.

_____ The listed MBE/WBE is bankrupt or insolvent.

_____ The listed MBW/WBE fails or refuses to perform his/her subcontract or furnish the listed materials.

_____ The work performed by the listed subcontractor is unsatisfactory according to industry standards and is not in accordance with the plans and specifications; or the subcontractor is substantially delaying or disrupting the progress of the work.

If replacing subcontractor:

Name of replacement subcontractor: _____

The M/WBE status of the contractor is certified by the NC Office of Historically Underutilized Businesses (required). _____ Yes _____ No

Dollar amount of original contract \$ _____

Dollar amount of amended contract \$ _____

Other Proposed Action:

_____ Increase total dollar amount of work

_____ Add additional subcontractor

_____ Decrease total dollar amount of work

_____ Other

Please describe reason for requested action: _____

If adding additional subcontractor*

The M/WBE status of the contractor is certified by the NC Office of Historically Underutilized Businesses (required). _____ Yes _____ No

Please attach Letter of Intent or executed contract document

Dollar amount of original contract \$ _____

Dollar amount of amended contract \$ _____

Interoffice Use Only:

Approval __ Y __ N

Date _____

Signature _____

Proof of Payment Certification
M/WBE Contractors, Suppliers, Service Providers

Project Name: _____ Pay Application No. _____

Prime Contractor: _____ Purchase Order No. _____

Current Contract Amount (including change orders): \$ _____

Requested Payment Amount for this Period: \$ _____

Is this the final payment? ___ Yes ___ No

Firm Name	*M/WBE Category	Total Amount Paid from this Pay Request	Total Contract Amount (including changes)	Total Amount Remaining

*M/WBE categories: Black, African American (**B**), Hispanic, Latino (**L**), Asian American (**A**), American Indian (**I**), Female (**F**), Socially and Economically Disadvantaged (**S**), Disabled (**D**)

Date: _____

Certified By: _____
Name

Title

Signature

BID BOND

KNOW ALL MEN BY THESE PRESENT, THAT WE _____

as Principal, and _____
as Surety, who is duly licensed to act as Surety in North Carolina, are held and firmly bound unto
the Greenville Utilities Commission, Greenville, NC, as Obligee, in the penal sum of _____
_____ DOLLARS (\$ _____) (5% Bid Bond),
lawful money of the United States of America, for the payment of which, well and truly to be
made, we bind ourselves, our heirs, administrators, successors and assigns, jointly and severally,
firmly by these present.

SIGNED, Sealed and dated this _____ day of _____, 2025.

WHEREAS, the said Principal is herewith submitting a Proposal for

INSTALLATION OF HVAC UPGRADE FOR ADMINISTRATION BUILDING

and the Principal desires to file this Bid Bond in Lieu of making the cash deposit as required by
the bidding documents contained herein;

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION is such that if the
principal shall be awarded the Purchase Order for which the bid is submitted and shall accept the
Purchase Order within ten (10) days after the award of same to the principal, then this obligation
shall be null and void; but if the principal fails to so accept such purchase order as required by
the bidding documents contained herein, the Surety shall, upon demand, forthwith pay to the
Obligee the amount set forth in the first paragraph hereof, and upon failure to forthwith make
such payment, the Surety shall pay the Obligee an amount equal to double the amount of this Bid
Bond as set forth in the first paragraph hereof. Power of Attorney from the surety to is Attorney-
in-Fact is attached hereto.

Principal

By _____(SEAL)

Corporate Surety

By _____(SEAL)

PERFORMANCE BOND/PAYMENT BOND

Date of Execution: _____

Name of Principal: _____

(Contractor) _____

Name of Surety: _____

Name of Contracting
Body: _____

Amount of Bond: _____

Project: _____

KNOW ALL THESE MEN BY THESE PRESENT, That We, the Principal and Surety above named, are held and firmly bound unto the above named Contracting Body, hereinafter called the Contracting Body, in the penal sum of the amount stated above the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these present.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal entered into a certain Contract with the Contracting Body, identified as shown above and hereto attached.

NOW, THEREFORE, if the Principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of said Contract during the original term of said Contract and any extensions there of that may be granted by the Contracting Body, with or without notice to the Surety, and during the life of any guaranty required under the Contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any and all duly authorized modifications of said Contract that may hereafter be made, notice of which modifications to the Surety being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above bounded parties have executed this instrument under the several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed, and these present duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in five (5) counterparts.

Witness:

(Proprietorship or Partnership)

ATTEST:

By: _____

Title: _____
(Corporate Secretary or
Assistant Secretary Only)

CONTRACTOR:

(Trade or Corporate Name)

By: _____

Title: _____

(CORPORATE SEAL)

Witness:

Countersigned:

N.C. Licensed Resident Agent

(Name and Address – Surety Agent)

Surety Company Name and N.C.
Regional or Branch Office Address

SURETY COMPANY:

By: _____

Title: _____
(Attorney-in-Fact)

(SURETY SEAL)

GREENVILLE UTILITIES COMMISSION

ADMIN BUILDING HVAC UPGRADE Greenville, NC

NV5 Project #: 24-0006120

CONSTRUCTION DOCUMENTS

April 24, 2025

Project Manual

Prepared By



NV5 Engineers and Consultants, Inc.

**3300 Regency Parkway, Suite 100
Cary, NC 27518**

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ACKNOWLEDGEMENTS

CLIENT

GREENVILLE UTILITIES COMMISSION

401 S Greene Street
Greenville, NC 27834

1.1 **DESIGN TEAM**

NV5 Engineers and Consultants, Inc.

(Engineer of Record / MEP)
3300 Regency Parkway, Suite 100
Cary, NC 27518

MHAWorks, PA

(Architect)
409 Evans Street, Suite C
Greenville, NC 27858

DESIGNER SEALS PAGE

NV5 Engineers and Consultants, Inc.
(Engineer of Record / MEP)
3300 Regency Parkway, Suite 100
Cary, NC 27518



MHAWorks, PA
Jeff Trussler, AIA, License #6064
jtrussler@mhaworks.com
252-329-0119
409 Evans Street, Suite C
Greenville, NC 27858



SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and drawing conventions.
9. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: GUC Admin Building HVAC Upgrade

1. Project Location: 401 South Greene Street, Greenville, NC 27858

B. Owner: **Greenville Utilities Commission**

1. Owner's Representative: Vincent Malvarosa

C. Engineer: Mr. Jeff Cappelle, NV5, 3300 Regency Parkway, Suite 100, Cary, NC 27518, 919-836-4800

1. The terms designer, A-E, architect, architect-engineer, engineer, and engineer-architect, etc., when used in these Contract Documents, shall, unless otherwise specifically defined, mean NV5, 3300 Regency Parkway, Suite 100, Cary, NC 27518.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

- B. This project consists of replacement of the existing HVAC systems serving the second and third floor of the Admin Building including new rooftop air handling units RTU-1 and RTU-2, new overhead ductwork distribution and air terminal units, new BAS controls. The project will be

phased construction as identified on the construction documents to renovate one floor at a time and maintain building occupancy on remaining floors.

1. Project will be constructed under a single prime contract.

C. Engineer's Drawings:

1. The Engineer's drawings are an integral part of this contract and shall serve as the working drawings. Dimensions, locations and layouts on the drawings shall be field verified by the Contractor. Work effort shall be governed by actual field locations and distances.
2. Contractor shall coordinate with any other contractor and their plans to avoid interferences and conflicting requirements. If there are major changes required to avoid conflicts, Contractor shall notify Engineer. Engineer will issue written permission and obtain agreement on required adjustments before construction occurs.
3. Discrepancies between different drawings, between drawings and field conditions, or between drawings and specifications shall immediately be brought to Engineer's attention for resolution.
4. List of Project Drawings:
 - a. G001 – Cover Sheet
 - b. G002 – Appendix B Sheet
 - c. A1.1 – Demolition Reflected Ceiling Plan & Notes
 - d. A1.2 – Renovation Reflected Ceiling Plan & Notes
 - e. A1.3 – Demolition Reflected Ceiling Plan & Notes
 - f. A1.4 – Renovation Reflected Ceiling Plan & Notes
 - g. A1.5 – Demolition/Renovation Floor Plan & Notes
 - h. M001 – Mechanical Legend, Notes and Abbreviations
 - i. MD101-1 – Mechanical Ductwork Demo Plan – Level 3 – Phase I
 - j. MD102-1 – Mechanical Ductwork Demo Plan – Roof – Phase I
 - k. MD201-1 – Mechanical Piping Demo Plan – Level 3 – Phase I
 - l. M101-1 – Mechanical Ductwork Plan – Level 3 – Phase I
 - m. M102-1 – Mechanical Ductwork Plan – Roof – Phase I
 - n. M201-1 – Mechanical Piping Plan – Level 3 – Phase I
 - o. M202-1 – Mechanical Piping Plan – Roof - Phase I
 - p. MD101-2 – Mechanical Ductwork Demo Plan – Level 2 – Phase II
 - q. MD102-2 – Mechanical Ductwork Demo Plan – Roof – Phase II
 - r. MD202-2 – Mechanical Piping Demo Plan – Roof - Phase II
 - s. M101-2 – Mechanical Ductwork Plan – Level 2 - Phase II
 - t. M102-2 – Mechanical Ductwork Plan – Roof - Phase II
 - u. M103-2 – Mechanical Structural Coordination Plan – Roof - Phase II
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- kk. E104 – Electrical Power Plan – Level 4 Phase I
- ll. E105 – Electrical Power Plan – Level 4 - Phase II
- mm. E202 – Electrical Lighting Ceiling Plan – Level 2
- nn. E203 – Electrical Lighting Ceiling Plan – Level 3
- oo. E501 – Electrical Details
- pp. E601 – Electrical Schedules

1.4 ACCESS TO SITE

- A. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Limits: Confine construction operations to areas of work indicated on drawings.
 - 2. Driveways, Walkways and Entrances: Keep driveways, parking and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather tight condition throughout construction period. Repair damage caused by construction operations.
- C. Contractor shall provide sticky mats and maintain/clean mats at each exit of the construction zone.
- D. Lay down and storage requirements will be discussed during pre-construction. Pending the number of laborers, they may need to carpool due to limited parking.

1.5 WORK RESTRICTIONS

- A. Contractor shall provide 1 and 3 week look aheads weekly to coordinate potentially disruptive work activities with office functions
- B. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than five working business days in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Owner not less five working business days in advance of proposed disruptive operations.
 - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Nonsmoking Building: Smoking is not permitted within the building, on the owner property, or within 100 feet of entrances, operable windows, or outdoor-air intakes.
- F. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.

1.6 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Construction schedule updating reports.
 - 3. Site condition reports.
 - 4. Special reports.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting schedules and reports.
 - 2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- C. Construction Schedule Updating Reports: Submit with Applications for Payment.
- D. Site Condition Reports: Submit at time of discovery of differing conditions.
- E. Qualification Data: For scheduling consultant.

1.5 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 - 2. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 - 3. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
 - 4. Punch List and Final Completion: Include not more than 15 days for completion of punch list items and final completion.
- C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- D. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- E. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for the Notice to Proceed. Base schedule on the startup construction schedule and additional information received since the start of Project.

- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule two days before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Engineer, Owner, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 3. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Engineer's Digital Data Files: Electronic copies of digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals at the discretion of the Architect.
 - 1. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.

- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 10 days for review of each resubmittal.
- D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
 3. Include the following information for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of subcontractor.
 - g. Name of supplier.
 - h. Name of manufacturer.
 - i. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
 - j. Number and title of appropriate Specification Section.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Other necessary identification.

4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
 - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
 5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return without review submittals received from sources other than Contractor.
 - a. Transmittal Form for Paper Submittals: Use AIA Document G810.
 - b. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
 - 1) Project name.
 - 2) Date.
 - 3) Destination (To:).
 - 4) Source (From:).
 - 5) Name and address of Engineer.
 - 6) Name of Construction Manager.
 - 7) Name of Contractor.
 - 8) Name of firm or entity that prepared submittal.
 - 9) Names of subcontractor, manufacturer, and supplier.
 - 10) Category and type of submittal.
 - 11) Submittal purpose and description.
 - 12) Specification Section number and title.
 - 13) Specification paragraph number or drawing designation and generic name for each of multiple items.
 - 14) Drawing number and detail references, as appropriate.
 - 15) Indication of full or partial submittal.
 - 16) Transmittal number.
 - 17) Submittal and transmittal distribution record.
 - 18) Remarks.
 - 19) Signature of transmitter.
- E. Electronic Submittals: Electronic Submittals may be made for 8-1/2" x 11" format submittal documents only. Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Transmittal Form for Electronic Submittals: Use pdf of same form required as paper submittals, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.

- d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
- F. Options: Identify options requiring selection by Engineer.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements:
- 1. Submit electronic submittals via email as PDF electronic files.
 - a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a notarized statement on original paper copy certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file, or
 - b. Three opaque copies of each submittal. Engineer will retain two copies; remainder will be returned.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.

- f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 - 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 24 by 36 inches.
 - 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
 - b. Three opaque copies of each submittal. Engineer will retain two copies; remainder will be returned.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 - 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 - 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return one submittal with options selected for contractor's use as project record sample.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Submit product schedule in the following format:
 - a. PDF electronic file, or.
 - b. Three paper copies of product schedule or list unless otherwise indicated.
Architect will return two copies.
- F. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

- S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- T. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."
- U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEERS'S ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action required.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittal review by the designer shall be only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract Documents. This review shall not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of the work with other trades or construction safety precautions, all of which shall be the sole responsibility of the Contractor. Review of a specific item shall not indicate that the designer has reviewed the entire assembly of which the item is a component. The designer shall not be required to review partial submissions or those for which submissions of correlated items have not been received
- F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 2. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
 - 3. Specific test and inspection requirements are not specified in this Section.

1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- D. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.4 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.

12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 5. Other required items indicated in individual Specification Sections.
- C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.5 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - d. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.
 - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.6 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 015030 – TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 GENERAL

- A. Provide temporary connection to existing building utilities or provide temporary facilities as required herein or as necessary to carry out the work.
- B. Use qualified tradesmen for installation of temporary services and facilities. Locate, modify and extend temporary services and facilities where they will serve the project adequately and result in minimum interference with the performance of the work.
- C. The contractor is responsible for the lock and tag out of all power sources and HVAC equipment. Notify the owner at least 48 hours in advance of the work that systems will be removed from service in the event that the systems and/or equipment service other buildings.
- D. The owner may adjust the location of furniture, books, computers, records, equipment, etc. prior to the contractor's arrival date as specified.

1.2 WATER SERVICE

- A. The Owner will supply a source of water to the general area of the building. Contractor bears all expense of heating and getting water to the work and decontamination areas. When the work is performed during times of freezing temperatures, the contractor shall be responsible for protection of existing systems to prevent damage from the freezing temperatures.
- B. After completion of use, connections and fittings shall be removed without damage or alteration to existing water piping and equipment.

1.3 ELECTRICAL SERVICE

- A. General: Comply with applicable NEMA, NEC and UL standards and governing state and local regulations for materials and layout of temporary electric service.
- B. Ground Fault Protection: Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
- C. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity and power characteristics to accommodate performance of work during the construction period.
- D. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.

1.4 FIRST AID

- A. A minimum of one first aid kit shall be located in the clean room for each interior work area. Additional first aid kits as the contractor feels are adequate or are required by law shall be located throughout the work area.

1.5 FIRE EXTINGUISHERS

- A. Comply with the applicable recommendations of NFPA Standard 10 - "Standard for Portable Fire Extinguishers." Locate fire extinguishers where they are most convenient and will be effective for their intended purpose, but provide not less than one extinguisher in each work area equipment room and one in the clean room of the personnel decontamination unit.

1.6 TOILET FACILITIES

- A. Contractors may use the restrooms on the respective floor in construction. Contractor shall clean restrooms during use maintain/restore to conditions prior to contractor use.

1.7 PARKING

- A. Park only in areas designated by the owner. Parking at the site will be limited by the owner's operations and other activities at the site. Employees of the contractor may have to park off the project site and be transported to the site by the contractor. All parking fees and permits shall be the responsibility of the contractor.

1.8 SECURITY

- A. Maintain personnel on-site at all times any portion of the work areas are open or not properly secured. Secure work areas completely at the end of each day. Provide hard barriers, fencing, locks etc. as necessary to prevent unauthorized entry into the site and work area.

1.9 STORAGE

- A. Supply temporary storage required for storage of equipment and materials for duration of project. Trailer and storage/waste dumpsters shall be maintained in areas designated by the owner. Coordinate placement and locations of the trailers and dumpsters with the owner at least 48 hours in advance of their arrival.

END OF SECTION 015030

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Coordination of Owner-installed products.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 - 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
 - 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning demolition, investigate and verify the existence and location of mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of hydronic water service piping; electrical services, and other utilities.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. General: Provide personnel capable of performing accurate field measurements to:
 - 1. Establish limits on use of Project site.
 - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location, level and plumb, of every major element as the Work progresses.
 - 5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.

3.4 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level unless specified otherwise.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.5 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.

- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements"

3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

- B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
3. Section 017900 "Demonstration and Training" for requirements for instructing Owner's personnel.

1.2 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.5 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.
 - 5. Submit test/adjust/balance records.
 - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 - 6. Advise Owner of changeover in heat and other utilities.
 - 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 - 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Complete final cleaning requirements, including touchup painting.
 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of five (5) days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.

1.6 FINAL COMPLETION PROCEDURES

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment.
 2. Certified List of Incomplete Items: Submit certified copy of Engineers Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

3. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Engineer will return annotated copy.

1.8 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - c. Clean exposed interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances.
 - d. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - e. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - f. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - g. Remove labels that are not permanent.
 - h. Leave Project clean and ready for occupancy.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit two (2) copies on digital media acceptable to Owner.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - 2. Three (3) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.
- C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.
 - 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.
- B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- C. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Engineer.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.

5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor is delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.

2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
- F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Requirements:
 - 1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
- B. Record Specifications: Submit one scanned PDF electronic files of Project's annotated Record Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one annotated PDF electronic file and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised Drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

- b. Record data as soon as possible after obtaining it.
 - c. Record and check the markup before enclosing concealed installations.
- 2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
- 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
- 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as scanned PDF electronic file(s) of marked-up paper copy of Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

- B. Format: Submit miscellaneous record submittals as scanned PDF electronic file(s) of marked-up miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit one copies within seven days of end of each training video.
 - 1. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.

- f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

END OF SECTION 017900

SECTION **08 11 13 - HOLLOW METAL DOORS AND FRAMES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Exterior standard steel doors and frames.
- B. Related Requirements:
 - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 7. Details of anchorages, joints, field splices, and connections.

8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

C. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches (75 by 127 mm)**.
2. Fabrication: Prepare Samples approximately **12 by 12 inches (305 by 305 mm)** to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

- D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum **4-inch- (102-mm-)** high wood blocking. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ceco Door; ASSA ABLOY.
 2. Curries Company; ASSA ABLOY.
 3. Deansteel Manufacturing Company, Inc.
 4. Fleming Door Products Ltd.; Assa Abloy Group Company.
 5. Karpen Steel Custom Doors & Frames.
 6. LaForce, Inc.
 7. Mesker Door Inc.

8. Pioneer Industries.
9. Republic Doors and Frames.
10. Security Metal Products; a brand of ASSA ABLOY.
11. Steelcraft; an Allegion brand.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Smoke- and Draft-Control Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
- B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.
- C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.40 deg Btu/F x h x sq. ft. (2.27 W/K x sq. m) when tested according to ASTM C 518.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Maximum-Duty Doors and Frames: SDI A250.8, Level 4; SDI A250.4, Level A..
 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A40 (ZF120) coating.
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Manufacturer's standard to meet required thermal performance.
 - i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation or laminated mineral board core for fire-rated doors.
 2. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A40 (ZF120) coating.
 - b. Construction: Full profile welded.
 - c. Profile: Provide kerfed frame for locations indicated to be fire or smoke rated to receive gaskets as required to provide indicated fire and smoke rating.
3. Exposed Finish: Prime.

2.4 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
- 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
 - 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
- 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.6 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- G. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.7 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch (19 mm)** beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 4. Terminated Stops: Terminate stops **6 inches (152 mm)** above finish floor with a 90-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with SDI A250.11.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - 2. Fire-Rated Openings: Install frames according to NFPA 80.
 - 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 4. Solidly pack mineral-fiber insulation inside frames.
 - 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - 6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 - 1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - 3. Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Other doors to the extent indicated.
 - 2. Cylinders for door hardware specified in other Sections.
 - 3. Electrified door hardware.
 - 4. Thresholds at Exterior Door and Entrance Systems as specified in other Sections
- B. Related Sections include the following:
 - 1. Division 08 Section "Hollow Metal Doors and Frames" for door silencers provided as part of hollow-metal frames.
 - 2. Division 08 Section "Flush Wood Doors" for provided as part of fire-rated labeled assemblies.
 - 3. Section 08 31 13 "Access Doors and Frames" for access door hardware, except cylinders.
 - 4. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" for installation of entrance door hardware, except cylinders.
 - 5. Division 26 – Electrical.

1.3 SUBMITTALS

- A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples for Initial Selection: For each finish, color, and texture required for each type of door hardware indicated.
- C. Samples for Verification: Submit minimum 2-by-4-inch plate Samples of each type of finish required, except primed finish.
- D. Product Certificates: For electrified door hardware, signed by product manufacturer.
 - 1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
- E. Qualification Data: For Installer.

1. Installer shall submit a letter of reference from a Hardware Supplier.
 2. Installer shall submit a list of employees that will be performing work on this project along with recent relevant experience for each individual listed.
- F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
- G. Warranty: Special warranty specified in this Section.
- H. Shop Drawings: Details of electrified door hardware, indicating the following:
1. Wiring Diagrams: For power, signal, and control wiring and including the following:
 - a. Details of interface of electrified door hardware and building safety and security systems.
 - b. Schematic diagram of systems that interface with electrified door hardware.
 - c. Point-to-point wiring.
 - d. Risers.
 - e. Elevations doors controlled by electrified door hardware.
 2. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.
- I. Other Action Submittals:
1. Door Hardware Sets: Prepared by Installer, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
 - b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - c. Content: Include the following information:
 - 1) Identification number, location, hand, fire rating, and material of each door and frame.
 - 2) Type, style, function, size, quantity, and finish of each door hardware item.
 - 3) Complete designations of every item required for each door or opening including name and manufacturer.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - 6) Explanation of abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for door hardware.
 - 8) Door and frame sizes and materials.
 - 9) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
 - a) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter;

authorized person wants to exit; unauthorized person wants to enter;
unauthorized person wants to exit.

10) List of related door devices specified in other Sections for each door and frame.

- d. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
 - e. Submittal Sequence: Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in Project construction schedule. Submit the final door hardware sets after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.
2. Keying Schedule: Prepared by or under the supervision of Manufacturer and Owner, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Furnish 3 dozen extra screws and other fasteners of each size, type, and finish used with the hardware items provided.
 - 2. Extra materials shall be stored on-site as directed by Owner.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
- 1. Installer's responsibilities include supplying and installing door hardware.
 - 2. Installer shall have warehousing facilities in Project's vicinity.
 - 3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 - 4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

- D. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
1. Air Leakage Rate: Maximum air leakage of **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** at the tested pressure differential of **0.3-inch wg (75 Pa)** of water.
- E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- F. Means of Egress Doors: Latches do not require more than **15 lbf (67 N)** to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- G. Accessibility Requirements: Comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1 for door hardware on doors in an accessible route.
1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than **5 lbf (22.2 N)**.
 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: **5 lbf (22.2 N)** applied perpendicular to door.
 - b. Sliding or Folding Doors: **5 lbf (22.2 N)** applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than **1/2 inch (13 mm)** high.
 4. Closers: Adjust door and gate closer sweep periods so that, from an open position of 90 degrees, the time required to move the door to a position of 12 degrees from the latch is 5 seconds minimum.
- H. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Address for delivery of keys.
- I. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 2. Inspect and discuss preparatory work performed by other trades.
 3. Inspect and discuss electrical roughing-in for electrified door hardware.
 4. Review sequence of operation for each type of electrified door hardware.
 5. Review required testing, inspecting, and certifying procedures.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys to Owner by registered mail or overnight package service.
 - 1. Permanent cores shall be installed by General Contractor at date of acceptance by Owner.

1.7 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Existing Openings: Where new hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide for proper operation.
- D. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- E. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

1. Warranty Period: Three years from date of Final Acceptance, unless otherwise indicated.
 - a. Electromagnetic Locks: Five years from date of Final Acceptance.
 - b. Exit Devices: Three years from date of Final Acceptance.
 - c. Manual Closers: 10 years from date of Final Acceptance.

1.9 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Final Acceptance, provide twelve months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated on Floor Plans and Door Hardware Sets indicated in Part 3 "Door Hardware Sets" Article.
 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products and products equivalent in function and comparable in quality to named products and products complying with BHMA standard referenced.
 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.
 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- C. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
 - 1. Three Hinges: For doors with heights 61 to 90 inches.
- B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- C. Hinge Weight: Unless otherwise indicated, provide the following:
 - 1. Doors with Closers: Antifriction-bearing hinges.
 - 2. Interior Doors: Standard-weight hinges.
- D. Hinge Base Metal: Unless otherwise indicated, provide the following:
 - 1. Exterior Hinges: Stainless Steel, with non-removable steel pin.
- E. Fasteners: Comply with the following:
 - 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - 2. Wood Screws: For wood doors and frames.
 - 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
 - 4. Screws: Phillips flat-head. Finish screw heads to match surface of hinges.

2.3 HINGES

- A. Butts and Hinges: BHMA A156.1.
- B. Template Hinge Dimensions: BHMA A156.7.
- C. Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 - 3. PBB, Inc. (PBB).
 - 4. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
 - a. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

2.4 LOCKS AND LATCHES, GENERAL

- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and 2012 North Carolina State Building Code.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
- B. Latches and Locks for Means of Egress Doors: Comply with 2012 North Carolina Building Code. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

- C. Lock Trim:
 - 1. Levers: Forged.
 - 2. Escutcheons: Forged.
 - 3. Dummy Trim: Match lever lock trim and escutcheons.
- D. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Mortise Locks: Minimum **3/4-inch** latch bolt throw.
- E. Strikes: Use existing locations at existing frames Custom strikes shall be made to fit existing holes in frames. Strikes shall have curved lip extended to protect frame, and shall be finished to match door hardware set. Modify and reinforce existing frames as required for new strike plate requirements.
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.

2.5 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
- B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1
 - 1. Manufacturers:
 - a. Yale; Div. of ASSA ABLOY Group Company (YA) – **Storeroom Lockset: CRR 8805FL LC – 626**
 - b. Best Access Systems; Div. of The Stanley Works (BAS).
 - c. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
 - d. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 - e. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).

2.6 DOOR BOLTS

- A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Fire-Rated Surface Bolts: Minimum **1-inch** throw; listed and labeled for fire-rated doors.
 - 2. Mortise Flush Bolts: Minimum **3/4-inch** throw.
- B. Dustproof Strikes: BHMA A156.16, Grade 1.
 - 1. Manufacturers:
 - a. Hager Companies (HAG).
 - b. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
 - c. Trimco (TBM).
- C. Manual Flush Bolts: BHMA A156.16, Grade 1; designed for mortising into door edge.
 - 1. Manufacturers:
 - a. Hager Companies (HAG).
 - b. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - c. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
 - d. Trimco (TBM).

2.7 LOCK CYLINDERS

- A. Standard Lock Cylinders: BHMA A156.5, Grade 1.
- B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
 - 1. Number of Pins: Seven.
 - 2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following and will be provided by the Owner and GC installed:
 - 1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
 - a. Manufacturer: Medeco; a Division of ASSA ABLOY Group company (MD). – **BiLevel Mortise. Model: 10 0200 J 26 FB CT-Z47 P – Owner provided, GC installed.**
 - b. Same manufacturer as for locks and latches.

2.8 KEYING

- A. Keying System: Unless otherwise indicated, provide a factory registered keying system complying with the following requirements **(Shall be provided by the Owner and installed with the core as noted above and below)**:
 - 1. Existing System: **Master key or grand master key locks to Owner's existing GUC system. Keying shall be completed by the Owner for coordination and the core shall be installed by the GC for each hardware set as provided by the Owner.**
- B. Keys: Provide nickel silver keys complying with the following:
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - 2. Quantity: Supply three (3) extra key blanks for each lock.

2.9 OPERATING TRIM

- A. Standard: BHMA A156.6.
- B. Materials: Fabricate from stainless steel, unless otherwise indicated.
- C. Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. Rockwood Manufacturing Company (RM).
 - 3. Trimco (TBM).

2.10 CLOSERS

- A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." and North Carolina State Building Code, Vol. 1-C.
 - 1. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: **5 lbf** applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than **30 lbf** to set door in motion and not more than **15 lbf** to open door to minimum required width.
- C. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- D. Surface Closers: BHMA A156.4, Grade 1. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
 - 1. Manufacturers:
 - a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
 - b. LCN Closers; an Ingersoll-Rand Company (LCN).
 - c. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).

2.11 FLUSHBOLTS

- A. Flush Bolts: ANSI / BHMA A156.16
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. DCI; 780F
 - b. Ives; FB458
 - c. Trimco.; 3917
 - 2. Provide minimum 1/2" diameter rods of brass or stainless steel, with minimum 12" long rods for doors up to 7'-0" in height. Provide longer rods as needed for doors exceeding 7'-0" in height.
 - 3. Provide dustproof strikes for bottom flush bolt applications, except where special threshold construction provide non-recessed strike for bolt.

2.12 DOOR GASKETING

- A. Standard: BHMA A156.22

- B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- C. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- D. Gasketing Materials: ASTM D 2000 and AAMA 701/702.
- E. Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. National Guard Products (NGP).
 - 3. Pemko Manufacturing Co. (PEM).
 - 4. Zero International (ZRO).

2.13 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. National Guard Products, Inc.
 - b. Reese Enterprises, Inc.
 - c. Zero International, Inc.
 - 2. Except as otherwise indicated, provide standard threshold units of type, size, and profile as shown or indicated.
 - 3. Metal shall be extruded aluminum, 6063-T5 alloy.
 - 4. If possible, provide thresholds that are 1" wider than depth of frame except as otherwise noted.
- B. Thresholds at exterior doors and entrance systems:
 - 1. Provide adjustable thresholds with integrated, gasketed thermal breaks.
 - 2. Provide finished dimension that is equal to width of adjacent framing system.

2.14 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and

BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

- C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a. Mortise hinges to doors.
 - b. Strike plates to frames.
 - 3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
 - a. Surface hinges to doors.
 - b. Closers to doors and frames.
 - c. Surface-mounted exit devices.
 - 4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 5. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.15 FINISHES

- A. Standard: BHMA A156.18, as indicated in door hardware sets.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.
- C. Door and Frame Preparation (ECU Housing Guideline)
 - 1. Before hardware installation, verify that all doors and frames are properly prepared to receive the specified hardware.
 - 2. Hollow metal frames shall be prepared for ANSI strike plates per A115.1-2 (4-7/8"high), hinge preps will be mortised and reinforced with a minimum of 10 gauge reinforcement material; minimum of 14 gauge reinforcement material for closer.
 - 3. Hollow metal doors shall be properly prepared and reinforced with a minimum of 16 gauge material for either mortised or cylindrical locks as specified. It is preferred that all hollow metal doors receiving door closers have 14 gauge reinforcement. If this is not possible, the use of sex bolts is mandatory.
 - 4. Wood doors shall be factory prepared to receive the scheduled hardware.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated on Drawings unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30

inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as directed by Owner.
 - 2. Furnish permanent cores to Owner for installation.
- E. Closers: When mounted to door face, shall be installed with through-bolts.
- F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
 - 1. Configuration: Provide one power supply for each door opening with electrified door hardware.
- G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."
- H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point **3 inches** from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

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

3.7 DOOR HARDWARE SETS

- A. Refer to drawings for door hardware schedule.

3.8 ELECTRONIC DOOR HARDWARE NOTES AND DIAGRAM

- A. All raceways and boxes provided by electrical contractor. Verify requirements with hardware and access control equipment.
- B. All raceways shall be concealed above ceilings or within walls where possible. Exposed raceways shall be permitted in areas with exposed overhead construction.
- C. Low Voltage wiring required for electronic Card Access systems shall be performed by Systems Supplier.
- D. Responsibilities:
 - 1. Hardware Contractor – Door Hardware, Door Contacts, Electrical Strikes, Electrical Latches, Power Transfer Hinges, Sounders/Power Supplies, Door Operators/Power Supplies, Push Pad Actuators.
 - 2. Security Contractor – Security Panel to Monitor Door Contacts.
 - 3. Access Control Contractor – Card Readers, Door Control Device/Power Supply, Elevator Control Device/Power Supply, Low Voltage Cabling, Site Controller Program
 - 4. Electrical Contractor – Back Box and Raceway Provisions, 120 VAC Provisions, Fire Alarm Connections
- E. Diagrams and Keyed Notes:
 - 1. Refer to drawings.

END OF SECTION 08 71 00

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.
 - 2. Grid suspension systems for gypsum board ceilings.
- B. Related Requirements:
 - 1. Section 05 40 00 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For embossed steel studs and tracks, firestop tracks, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C 645.
1. Embossed Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally equivalent to conventional ASTM C 645 steel studs and tracks.
 - 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) ClarkDietrich Building Systems.
 - 2) MarinoWARE.
 - 3) SCAFCO Steel Stud Company.
 - b. Minimum Base-Metal Thickness: As required by horizontal deflection performance requirements, but not less than 0.03 inch..
 - c. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 1-1/2 inches (38 mm).
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.0296 inch (0.752 mm).
 2. Depth: As indicated on Drawings.
- G. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: As indicated on Drawings.

2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: 2-1/2 inches (64 mm).
- D. Furring Channels (Furring Members):
 1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Metal Thickness: 0.0296 inch (0.752 mm).
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Chicago Metallic Corporation.
 - c. USG Corporation.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches (610 mm)** o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum **1/2-inch (13-mm)** clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs **6 inches (150 mm)** o.c.
- E. Direct Furring:
 - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
- F. Z-Shaped Furring Members:
 - 1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced **24 inches (610 mm)** o.c.

2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches (610 mm)** o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches (305 mm)** from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3 mm)** from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
1. Hangers: **48 inches (1219 mm)** o.c.
 2. Carrying Channels (Main Runners): **48 inches (1219 mm)** o.c.
 3. Furring Channels (Furring Members): **16 inches (406 mm)** o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Do not attach hangers to steel roof deck.
 5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within $1/8$ inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 1

SECTION **09 29 00** - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
- B. Related Requirements:
 - 1. Section 06 16 00 "Sheathing" for gypsum sheathing for exterior walls.
 - 2. Section 09 22 16 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
- C. Samples for Verification: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 2. Thickness: **5/8 inch (15.9 mm)**.
 3. Long Edges: Tapered.
- B. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 2. Thickness: **1/2 inch (12.7 mm)**.
 3. Long Edges: Tapered.
- C. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.

- b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 - 2. Core: **5/8 inch (15.9 mm)**, Type X.
 - 3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 - 4. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 - 5. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.
 - 6. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements according to test in Annex A1.
 - 7. Long Edges: Tapered.
 - 8. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- D. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 - 2. Core: **5/8 inch (15.9 mm)**, Type X.
 - 3. Long Edges: Tapered.
 - 4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 - 2. Core: **5/8 inch (15.9 mm)**, Type X.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
- 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 - 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.7 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch (1.5 mm)** of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than **8 sq. ft. (0.7 sq. m)** in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow **1/4- to 3/8-inch- (6.4- to 9.5-mm-)** wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide **1/4- to 1/2-inch- (6.4- to 12.7-mm-)** wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: Vertical surfaces unless otherwise indicated.
 - 2. Ceiling Type: Ceiling surfaces.
 - 3. Impact-Resistant Type: As indicated on Drawings.
 - 4. Mold-Resistant Type: As indicated on Drawings.

- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
 - 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, **16 inches (400 mm)** minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with **1/4-inch (6.4-mm)** gap where panels abut other construction or penetrations.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. Bullnose Bead: Use where indicated.
 - 3. LC-Bead: Use at exposed panel edges.
 - 4. L-Bead: Use where indicated.
 - 5. U-Bead: Use where indicated.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
- E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 51 23 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles for ceilings.
 - 2. Concealed suspension systems.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6-inches-in size.
- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Concealed Suspension-System Members: 6-inch-long Sample of each type.
 - 3. Exposed Moldings and Trim: Set of 6-inch-long Samples of each type and color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling 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. Ceiling suspension-system members.
 - 2. Method of attaching hangers to building structure.

- a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Minimum Drawing Scale: 1/8 inch = 1 foot.
 - B. Qualification Data: For testing agency.
 - C. Product Test Reports: For each acoustical tile ceiling, for tests performed by a qualified testing agency.
 - D. Evaluation Reports: For each acoustical tile ceiling suspension system and anchor and fastener type, from ICC-ES.
 - E. Field quality-control reports.
- 1.6 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For finishes to include in maintenance manuals.
- 1.7 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size tiles equal to 5 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each concealed grid and exposed component equal to percent of quantity installed.
- 1.8 QUALITY ASSURANCE
- A. Testing Agency Qualifications: Qualified according to the National Voluntary Laboratory Accreditation Program (NVLAP) for testing indicated.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
 - B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
 - C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL TILES, GENERAL

- A. Low-Emitting Materials: Acoustical tile ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Source Limitations:
 - 1. Acoustical Ceiling Tile: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system from single source from single manufacturer.
- D. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- E. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL TILES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Armstrong World Industries, Inc. – **Dune. 1774 Angled Tegalur. White.**
 2. United States Gypsum Company
 3. CertainTeed Corporation.
- B. Basis-of-Design: Orion 75 by USG
- C. Classification: Provide tiles complying with ASTM E 1264 for type, form, and pattern to match basis of design listed above.
- D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or

other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- D. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.
- F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.
- G. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

2.5 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong World Industries, Inc. – **Prelude XL 7800. White.**
 - 2. United States Gypsum Company.CertainTeed Corporation.
 - 3. CertainTeed Corporation.
- B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 coating designation.
 - 1. Structural Classification: Heavy-duty system.
 - 2. Access: Upward and, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, 24 by 24 inches unless noted otherwise.
 - 3. Profile Basis-of-Design: Match existing adjacent.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of

the following:

1. Armstrong World Industries, Inc.
 2. CertainTeed Corporation.
 3. United States Gypsum Company.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips and complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL SEALANT

- A. Acoustical Sealant for Exposed and Concealed Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pecora Corporation.
 - b. United States Gypsum Company.
 - c. Tremco.
- B. Acoustical Sealant for Concealed Joints:
- a. Pecora Corporation.
 - b. United States Gypsum Company.
 - c. Tremco.
- C. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 MISCELLANEOUS MATERIALS

- A. Acoustical Tile Adhesive: Type recommended by acoustical tile manufacturer, bearing UL label for Class 0-25 flame spread.
 1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Staples: 5/16-inch-long, divergent-point staples.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
 - 1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 - 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches o.c.
 - 3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 INSTALLATION OF DIRECTLY ATTACHED ACOUSTICAL TILE CEILINGS

- A. Adhesive Installation: Install acoustical tile by bonding to substrate, using amount of acoustical tile adhesive and procedure recommended in writing by tile manufacturer and as follows:
 - 1. Prime ceiling according to Cisca's "Ceiling Systems Handbook."
 - 2. Remove loose dust from backs of tiles by brushing.
 - 3. Install splines in joints between tiles; maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet and not exceeding 1/4 inch cumulatively.
 - 4. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
- B. Stapled Installation: Fasten acoustical tile to substrate using a minimum of two staples per tile that are installed in flanges of tile and as follows:
 - 1. Form double-lapped joint between tiles by securely pressing tile tongues into corresponding tile grooves.
 - 2. Maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet and not exceeding 1/4 inch cumulatively. Shim tile or correct substrate as required to maintain tolerance.
 - 3. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.
- D. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
 - 2. Install tiles with pattern running in one direction parallel to long axis of space.
 - 3. Install tiles with pattern running in one direction parallel to short axis of space.
 - 4. Install tiles in a basket-weave pattern.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Gypsum Board.
 - 2. Steel.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

- A. MPI Standards:
 - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional **5** percent, but not less than **1 gallon** of each material and color applied.

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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Sherwin-Williams Company (The).
 - 2. ICI Paints (Glidden Professional).
 - 3. PPG Architectural Finishes, Inc.
 - 4. Sherwin-Williams Company (The).
 - 5. Benjamin Moore & Co.

2.2 PAINT, GENERAL

- A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:
1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
 2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
 3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 4. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.
 - j. 1,2-dichlorobenzene.
 - k. Diethyl phthalate.
 - l. Dimethyl phthalate.
 - m. Ethylbenzene.
 - n. Formaldehyde.
 - o. Hexavalent chromium.
 - p. Isophorone.
 - q. Lead.
 - r. Mercury.
 - s. Methyl ethyl ketone.
 - t. Methyl isobutyl ketone.
 - u. Methylene chloride.
 - v. Naphthalene.
 - w. Toluene (methylbenzene).
 - x. 1,1,1-trichloroethane.
 - y. Vinyl chloride.
- C. Colors: **As selected by Architect from manufacturer's full range**

2.3 PRIMERS/SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.

1. VOC Content: E Range of **E3**.
2. Environmental Performance Rating: **EPR 3**.

B. Interior Alkyd Primer/Sealer: MPI #45.

1. VOC Content: E Range of **E2**.

2.4 METAL PRIMERS

A. Alkyd Anticorrosive Metal Primer: MPI #79.

1. VOC Content: E Range of **E2**.

2.5 LATEX PAINTS

A. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).

1. VOC Content: E Range of E3.
2. Environmental Performance Rating: **EPR 5.5**.

2.6 ALKYD PAINTS

A. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).

1. VOC Content: E Range of **E2**.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-

paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Gypsum Board Substrates:
 - 1. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.
 - a. Prime Coat: Interior institutional low-odor/VOC latex primer
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex **(semigloss). To match existing.**
- B. Steel Substrates:
 - 1. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: **Alkyd anticorrosive** metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd **(gloss).**

END OF SECTION 09 91 20

SECTION 230000 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 - 1. Submittals.
 - 2. Record documents.
 - 3. Maintenance manuals.
 - 4. Rough-ins.
 - 5. Mechanical installations.
 - 6. Cutting and patching.
 - 7. Owner Close-out Documentation
- B. Section includes product data for the following:
 - 1. Common motor requirements for HVAC equipment.
 - 2. Expansion fittings and loops for HVAC piping.
 - 3. Sleeves and sleeve seals for HVAC piping.
 - 4. Escutcheons for HVAC piping.
 - 5. Meters and gages for HVAC piping.

1.3 SCOPE OF WORK

- A. The work under this section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, tested, adjusted, and ready for operation.
- B. Construction Schedule:
 - 1. The project will be phased as outlined below. Project completion for turnover to Owner is to be December 12, 2025.
- C. Phasing: The project shall be phased construction as indicated on the drawings. Refer to drawings for specific requirements. General phasing requirements shall be as follows:

1. Phase 1: Level 3 and Level 4 (Roof/Penthouse)
 - a. Contractor shall maintain operations on Levels 1 and 2 for business continuity. Disruptions of service will be coordinated with owner at beginning of phase.
2. Phase 2: Level 2
 - a. Contractor shall maintain operations on Levels 1 and 3 for business continuity. Disruptions of service will be coordinated with owner at beginning of phase.
3. Board Room Schedule
 - a. The Board Room on Level 2 shall be maintained accessible and operational for Board meetings on the following dates. Contractor shall identify dates in construction schedule and coordinate with Owner for construction during meeting times.
 - 1) May 15, 2025
 - 2) June 12, 2025
 - 3) July 17, 2025
 - 4) August 21, 2025
 - 5) September 18, 2025
 - 6) October 16, 2025
 - 7) November 20, 2025
 - 8) December 18, 2025

- D. Contractor shall use existing stairwell for access to work areas. Building will remain occupied during construction and contractor shall minimize disruption to occupied areas. Refer to general conditions for building requirements.

1.4 RELATED WORK

- A. Principal classes of Work related to the Work of this section are specified to be performed under the indicated sections of the specifications. Refer to the indicated sections for description of the extent and nature of the indicated Work, and for coordination with related trades. This listing may not include all related Work items. It is the responsibility of the Contractor to coordinate and schedule the Work of this section with that of all other trades.
- B. The following work is not included in this section and will be provided under other sections, except as specified herein:
 1. Electrical power wiring for all HVAC equipment and to junction box(es) in mechanical areas where required to be within 100 feet of all terminal boxes where they are shown on the drawings or as required. Power wiring from these distributed junction box(es) to all control equipment (control panels, control valves, dampers, fan coil unit controllers, etc.) and all controls/interlock wiring shall be provided by the controls Contractor. Heat trace, motor starters, and variable speed drives that are not integral to equipment, unless specified otherwise.
 2. Structural supports necessary to distribute loading from equipment to roof or floor.

3. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing. Refer to Division 01, General Conditions.
4. Excavation and backfill.
5. Concrete work including concrete housekeeping pads and blocks for vibrating and rotating equipment, and cast-in-place manholes.
6. Flashing of roof and wall penetrations.
7. Painting, except as specified herein.

1.5 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION

1.6 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.
- B. Motors shall not exceed the characteristics listed in the applicable equipment schedules.

1.7 DEFINITIONS

- A. As used in this section, the following terms shall be understood to have the following meaning:
 1. "Contractor," or "Subcontractor," unless otherwise qualified, shall mean the installer of the work specified under this section, and shall be responsible for coordination of this work with the work of the ATC Contractor.
 2. "Furnish" shall mean purchase and deliver to the project site, complete with every necessary appurtenance and product support.
 3. "Install" shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting and proper operation at the proper location in the project.
 4. "Provide" shall mean furnish and install.
 5. "Work" shall mean all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.
 6. "Concealed" shall mean hidden from sight in chases, furred in spaces, shafts, embedded in construction, in a crawl space, and above hung ceilings.
 7. "Exposed" shall mean not installed underground or concealed as defined above.
 8. "Furnished by others" shall mean materials or equipment purchased under other sections of the general contract and installed by this section of the specifications by this trade Contractor.
 9. "Owner's Representative" shall be the party responsible to make decisions regarding all contractual obligations in reference to the Scope of Work for the Owner.

10. "Date of Substantial Completion" shall indicate the date where the work has been formally accepted as evidenced by completed final punchlist or where the work has reached the stage that the Owner obtains beneficial use and commences utilization of the installed systems for business or occupancy purposes. The General Requirements, Division 01, shall supersede this definition where specifically defined.
11. "Piping" shall mean, in addition to pipe or tubing, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.
12. "ATC" shall mean Automatic Temperature Controls, and shall be interchangeable with "BAS" (Building Automation System).

1.8 CODES, REFERENCES AND PERMITS

- A. Materials, installation of systems and equipment provided under this section shall be done in strict accordance with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, and any other Codes and Regulations having jurisdiction including but not limited to:
 1. All Applicable NFPA Standards
 2. State and Local Building Mechanical, Electrical, and Energy Codes
 3. American Society of Mechanical Engineers (ASME)
 4. American Society of Testing and Materials (ASTM)
 5. American National Standards Institute (ANSI)
 6. Underwriters' Laboratories, Inc. (UL)
 7. Occupational Safety and Health Administration (OSHA)
 8. Any other local codes or authorities having jurisdiction.
- B. Heating, pumping, process piping and refrigeration systems shall be installed by Contractors and personnel appropriately licensed in the State (Installing Contractor).
- C. All pressure vessels shall conform to ASME and State codes and regulations.
- D. All equipment shall meet the more efficient requirement:
 1. As shown on bid documents,
 2. Minimum efficiencies state in ASHRAE 90.1-2013, or
 3. Minimum efficiencies stated in the governing Energy Code.
- E. Unless otherwise specified or indicated, materials, workmanship and equipment performance shall conform with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, except when more rigid requirements are specified or are required by applicable codes but not limited to:
 1. Air Conditioning and Refrigeration Institute (ARI)
 2. American National Standards Institute (ANSI)
 3. American Society of Heating, Refrigeration and Air Conditioning (ASHRAE)
 4. American Society of Mechanical Engineers (ASME)
 5. American Society of Testing and Materials (ASTM)
 6. American Welding Society, Inc. (AWS)
 7. Associated Air Balance Council (AABC)
 8. Copper Development Association (CDA)

9. Factory Mutual System (FM)
10. Illuminating Engineering Society (IES)
11. Institute of Electrical and Electronics Engineers (IEEE)
12. Insulated Cable Engineers Association (ICEA)
13. Manufacturer's Standardization Society of the Valve & Fitting Industry (MSS)
14. National Electrical Contractors Association (NECA)
15. National Electric Manufacturers Association (NEMA)
16. National Environmental Balancing Bureau (NEBB)
17. North American Insulation Manufacturer's Association (NAIMA)
18. The Hydronics Institute (HI)
19. Thermal Insulation Manufacturer's Association (TIMA)

- F. Codes, laws and standards provide a basis for the minimum installation criteria acceptable. The drawings and specifications illustrate the scope required for this project, which may exceed minimum codes, laws and standards.
- G. The date of the code or standard is that in effect when the permits will be issued.
- H. Give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from authorities having jurisdiction. Deliver all certificates of inspection to the authorities having jurisdiction. No work shall be covered before examination and approval by the Owner's Representative, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work to conform to requirements, satisfactory to Owner's Representative, and without extra cost to the Owner. If work is covered before inspection and approval, this Contractor shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.9 GENERAL REQUIREMENTS

A. Nameplates

1. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, type or style, model number, catalog number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Maintenance Information

1. Systems and equipment which require periodic maintenance to maintain efficient operation shall be furnished with complete necessary maintenance information. Required routine maintenance actions, as specified by the manufacturer, shall be stated clearly and incorporated on a readily accessible label on the equipment. Such label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.

C. Equipment Guards

1. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

1.10 MATERIAL AND EQUIPMENT STANDARDS

- A. Where equipment or materials are specified with the name of a manufacturer, such specification shall be deemed to be used for the purpose of establishing a standard for that particular item. No equipment or material shall be used unless previously approved by the Owner's Representative.
- B. Substitutions (approved equals) may be offered for review provided the material, equipment or process offered for consideration is equal in every respect to that indicated or specified. In order for Requests for substitution to be considered, all must be submitted for pre-approval of manufacturer within thirty (30) days of award of contract. All requests must be accompanied by a list of minimum five (5)-year-old successful installations of similar scope (with Owner contact and phone number), complete specifications together with drawings or samples to properly appraise the materials, equipment or process. Allow thirty (30) days for Owner's Representative's review.
- C. If a substitution of materials or equipment in whole or in part is made, this Contractor shall bear the cost of any changes necessitated by any other trade as a result of said substitution.
- D. All materials, equipment and accessories provided under this section shall be new and unused products of recognized manufacturers as approved.

1.11 SUBMITTALS

- A. Conform to the requirements of Division 01, General Conditions, for schedule and form of all submittals unless specifically noted otherwise in this section. Coordinate this submittal with submittals for all other disciplines. Shop drawings and design layouts shall be prepared by licensed installing Contractors and shall note the name(s), license number(s) and license expiration date(s) of the Contractor(s) installing the mechanical systems.
- B. Definitions:
 - 1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than indicated in the Contract Documents.
 - 2. Acceptable Manufacturers: The mechanical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. In addition, the MATERIAL AND EQUIPMENT STANDARDS paragraph potentially allows for substitutions as being acceptable. These are acceptable only if, as a minimum, they:
 - a. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure (with the allowed pressure drop of dirty filters) using equal or less horsepower as the air handler listed in the schedules.
 - b. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings, and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean the Engineer has determined that the

manufacturer's products will fit within the available space – this determination is solely the responsibility of the Contractor.

C. Submittal Procedures, Format and Requirements

1. Review submittal packages for compliance with Contract Documents and then submit to Owner's Representative for review. Submit electronic searchable PDF files containing submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor shall check all documents for accuracy prior to submitting.
2. Each Shop Drawing shall indicate in title block, and each Product Data package shall indicate on cover sheet, the following information:
 - a. Title.
 - b. Equipment number.
 - c. Name and location of project.
 - d. Names of Owner, Engineer and Seller.
 - e. Names of manufacturers, suppliers, vendors, etc.
 - f. Date of submittal.
 - g. Whether original submittal or resubmitted.
3. Shop drawings showing manufacturer's product data shall contain detailed dimensional drawings (minimum ¼ inch = one (1) foot scale) including plans and sections (where physical clearance could be an issue). Provide larger scale details as necessary.
4. Submit accurate and complete description of materials of construction, manufacturer's published performance characteristics, sizes, weights, capacity ratings (performance data, alone, is not acceptable), electrical requirements, starting characteristics, wiring diagrams, and acoustical performance for complete assemblies. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
5. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its referenced to specific designation for product in drawings. Specifically identify equipment by name and number as indicated in specification and as shown on drawings.
6. Equipment with electrical connections shall include composite wiring diagrams.
7. Provide shop drawings showing details of piping connections to all equipment. If connection details are not submitted and connections are found to be installed incorrectly, this Contractor shall reinstall them within the original contract price.
8. Provide complete data for all auxiliary services and utilities required by submitted equipment. This shall include power, water and points of connection.
9. Provide a complete description of all controls and instrumentation required including electrical power connection drawing for all components and interconnection wiring to starters, detailed information on starters, control diagrams, termination diagrams, and all control interfaces with a central control system.
10. Provide installation and erection information including; lifting requirements, and any special rigging or installation requirements for all equipment.
11. The Owner's Representative shall approve all materials before commitment for materials is made.

D. Specifications, Schedule, and Control Sequence Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with each specification criteria listed in each paragraph for those submittals listed in Paragraph E.
2. The statement of compliance shall consist of a list of all paragraphs (line by line) identified in the all specification sections of Division 23 containing the equipment, including Part 2 and applicable Part 3 of those specification sections as well as unit controls providing all manufacturer's portions of the control sequences shown on the drawings for which the submitted product in the opinion of the manufacturer complies, deviates, or does not meet.
3. Where the proposed submittal complies fully, the word "comply" shall be placed opposite the paragraph number.
4. Where the proposed submittal does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
5. Verify each field of the associated schedule where associated technical data is presented and sequences are shown on the drawings. Where the submitted material does not 'comply' provide the value the submitted equipment will achieve based upon the specified conditions.
6. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question and the product will be rejected.
7. Submissions which do not include a point by point statement of compliance as specified shall be disapproved.

E. Submit shop drawings for equipment as requested in respective specification sections.

F. Submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in an individual (combined) submittal.

1. Do not submit multiple product information in a single bound manual.
2. Three-ring binders shall not be accepted

G. Deviations

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Owner's Representative.
2. Without letters flagging the deviation to the Owner's Representative, it is possible that the Engineer may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Owner's Representative, the Seller shall hold the Engineers, his consultants and the Owner harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Engineer has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Engineer.

H. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. This Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule: Allow at least ten (10) working days, exclusive of transmittal time, for review each time shop

drawing is submitted or resubmitted with the exception that twenty (20) working days, exclusive of transmittal time are required for the following:

1. HVAC temperature control submittals
2. Coordination Drawings
3. TAB final balancing reports.
4. O&M manuals
5. As built drawings
6. If more than five (5) shop drawings of a single trade are received in one (1) calendar week.

I. Responsibility

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. HVAC Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other sections. Work shall comply with approved submittals to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor the shop drawing errors or deviations from requirements of Contract Documents. The Engineer's noting of some errors while overlooking others will not excuse the HVAC Contractor from proceeding in error and will not absolve the Contractor from meeting the full design intent of the associated system(s). Contract Documents requirements are not limited, waived nor superseded in any way by review.
2. Inform Contractors, manufacturers, suppliers, etc. of scope and limited nature of review process and enforce compliance with contract documents.

J. In the event that the HVAC Subcontractor fails to provide Shop Drawings for any of the products specified herein:

1. The HVAC Subcontractor shall furnish and install all materials and equipment herein specified in complete accordance with these specifications.
2. If the HVAC Subcontractor furnishes and installs material and/or equipment that is not in complete accordance with these specifications, he shall be responsible for the removal of this material and/or equipment. He shall also be responsible for the replacement of this material and/or equipment with material and/or equipment that is in complete accordance with these specifications, at the direction of the Owner's Representative.
3. Removal and replacement of materials and/or equipment that is not in complete compliance with these specifications shall be done at no extra cost to the Owner.
4. Removal and replacement of materials and/or equipment that is not in complete compliance with these specifications shall not be allowed as a basis for a claim of delay of completion of the Work.

K. Mark dimensions and values in units to match those specified.

L. Submit Material Safety Data Sheets (MSD) on each applicable product with submittal.

M. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

1.12 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Manuals

1. Commence preparation of the Operating and Maintenance (O&M) Manuals immediately upon receipt of "Approved" or "Approved as Noted" shop drawings and submit each section within one (1) month. The final submission shall be no later than two (2) months prior to the projected date of Substantial Completion of the Project.
2. Each O&M document shall include the manufacturer's web address for equipment - specific O&M information for Internet access by the Owner.
3. The manual shall consist of (3) sets of manuals and include (3) sets of CDs, which shall contain the scanned content of the entire manual. The manual shall highlight the actual equipment used and not be a master catalog of all similar products of the manufacturer. The manual shall be submitted for review prior to creation of the CDs.
4. The Manual shall contain the following:

a. Operations Manual

- 1) Systems description including all relevant information needed for day-to-day operations and management including:
 - a) Start-up requirements and procedures, including Water Treatment systems.
 - b) Shut-down requirements and procedures, including Water Treatment systems.
 - c) Trouble-shooting checklist (i.e., common alarms with possible cause & effect, etc.).
- 2) Wiring diagrams, schematics, logic diagrams and sequence of operations that accurately depict the controls system.
- 3) Depiction of each interface screen where programmable logic and visual displays are provided. Descriptors shall be provided to define displayed data, alarms, etc.
- 4) A single sheet (for ease of removal) of all access codes and passwords necessary to access all levels of control and programming.

b. Maintenance Manual

- 1) Define all maintenance activities required to ensure system operation within manufacturers specified parameters. Maintenance documentation shall include:
 - a) Data retrieval sheet
 - b) Special instructions (i.e., lockout/tag-out, etc.)
 - c) Special tools (i.e., key, allen wrench, etc.)

- d) Tasks
 - e) Frequency
 - f) Required materials, lubricants, etc.
- 2) Provide table of all required activities plotted vs. interval with adequate fill-in-space for "activity completion date" and "comments". Where multiple instrument readings are required, provide data sheet formatted to accommodate activity.
 - 3) Provide as part of each package, lubricating charts indicating equipment tag number, location, equipment service, greasing and lubricating requirements, lubricants, and intervals.
 - 4) Provide as part of each package, a valve and system chart that corresponds to the valve tags. Provide directions for normal positions and positions for equipment failure modes.
 - 5) The HVAC Subcontractor shall furnish spare-parts data for each different item of equipment furnished. The data shall include a complete list of: parts and supplies, with current unit prices, lead time, and source of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the contract; and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 366 days at the particular installation. The foregoing shall not relieve the HVAC Subcontractor of any responsibilities under the guarantees specified herein.
 - 6) Provide copy of all warranty information including extended warranties where specified with associated date of substantial completion (commencement of warranty) and end date of coverage. Define all components/subsystems specifically included and excluded.
5. Provide O&M manuals for each of the following as a minimum:
- a. Valves and Accessories (all types, including charts for all balancing valves)
 - b. VFDs, Electric Motors and Starters
 - c. Pumps (Water systems)
 - d. Vibration Isolation
 - e. HVAC Control Systems

B. Record Documents

- 1. Refer to DIVISION 1, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.
- 2. Record Drawings (red-line drawings) will be updated by this Contractor daily for review with the monthly requisition. The record drawing shall be an accurate depiction of the systems as completed, including dimensions (vertical/horizontal) of concealed components off fixed building elements.
- 3. The HVAC Foreman shall maintain complete and separate set of prints of Contract Drawings at job site at all times and shall record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to the original design.
- 4. At completion of work the HVAC Contractor shall prepare a complete set of record drawings on AutoCAD showing all systems as actually installed. The Architectural background AutoCAD files will be made available for the Contractor's copying, at his

expense, to serve as backgrounds for the drawings. The HVAC Contractor shall transfer changes from field drawings onto AutoCAD drawings and submit copy of files and three (3) sets of prints to Owner's Representative for comments as to compliance with this section. CADD layering as established by the A & E design team shall be maintained with any and all changes done by the Contractor.

5. The Architect and Engineer are not granting to the Contractor any Ownership or property interest in the CADD Drawings by the delivery of the CADD Disks to the Contractor. The Contractor's rights to use the CADD disks and the CADD Drawings are limited to use for the sole purpose of assisting in the Contractor's performance of its contractual obligations under its contract with respect to the Project. The Architect and Engineer are granting no further rights. Any reuse or other use by the Contractor will be at the Contractor's sole risk and without liability to the Architect and Engineer. The Contractor hereby waives and releases any losses, claims, damages, liabilities of any nature whatsoever, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor. The Contractor, to the maximum extent permitted by law, hereby agrees to indemnify, defend and hold the Architect and Engineer harmless from all losses, claims, damages, liabilities, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor.
6. Record Drawings, shall show "as-built" condition of all plans, mechanical room part plans, details, sections, piping diagrams, control diagram and sequence changes and corrections to schedules. Schedules shall show actual manufacturer model numbers and capacities of final installed equipment.
7. Record drawings shall include the specific locations of the following life safety and control points/sensors:
 - a. All differential pressure sensors for fan and pump speed control.
8. The HVAC Contractor shall submit the record set for approval a minimum of three (3) weeks prior to seeking the permanent certificate of occupancy

1.13 COORDINATION

- A. Refer to Division 01, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.
- B. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as required.
- C. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other sections. Any conflicts shall be referred immediately to the Owner's Representative for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Owner's Representative's satisfaction at no expense to the Owner.
- D. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section may interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. Prepare and submit for approval 3/8 inch scale or larger working drawings and sections, clearly showing how the work is to be installed in relation to the work of other sections. If the work of this section is installed

before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.

- E. Keep fully informed as to the shape, size and position of all openings required for all apparatus, piping, ductwork, etc., and give information in advance to build openings into the work. Furnish all sleeves, pockets, supports and incidentals, and coordinate with the Owner's Representative for the proper setting of same.
- F. All distribution systems which require pitch or slope such as condensate drains and water piping shall have the right of way over those which do not.
- G. Make reasonable modifications in the work as required by structural interferences, interference with work of other trades, or for proper execution of the work without extra charge.
- H. Keep fully informed as to the size, shape and location of all openings required for the work of this section and give full information to all Subcontractors and the Owner's Representative.

1.14 BIM MODEL AND COORDINATION DRAWINGS

- A. Provide BIM model of the systems included in this specification section as required by Division 01.
- B. All relevant models will be incorporated into one (1) review file for use during coordination meetings. The Coordination Team shall utilize the most current version of Navisworks Manage clash detection software to expedite the drawing review process and resolution. Contractor Models must be submitted in a model format that is compatible with the most current version of Navisworks.
- C. Coordination Model: The coordination model will be reconciled by each Contractor to find the best collective solution to the coordination of all items.
 - 1. Each Contractor will supply a 3D Contractor Model for their own scope of work separated by areas as directed by General Contractor.
 - 2. Each Contractor will be responsible for working in harmony with the other Contractors to resolve coordination issues.
 - 3. Contractor models will be color coded to provide delineation between systems as directed by the General Contractor.
 - 4. 2D coordination drawings will still be required as directed by General Contractor and required for shop drawing approvals.
- D. Electronic Copies of Models: Submit to the Owner's Project Manager progress and final models when requested, including, at the end of the project, a model(s) appropriate for facilities management and maintenance purposes to be used in association with the Owner's Management System. Electronic copies of tabular data for equipment, spaces, building systems and other items specified by the Owner's Project Manager shall be submitted in a format specified by Owner.

- E. Time is of the essence on this project. Contractor is responsible for all efforts, methods, procedures and costs required to meet or better the scheduled dates. If, at any time, it is determined by the General Contractor or the Owner's Project Manager that this Contractor is not on schedule for any reason within the control or responsibility of the Contractor, the Contractor shall increase its manpower or work such overtime as is required to bring the work back within the Project Schedule. Such additional efforts shall be performed at no additional cost to the General Contractor or the Owner.
- F. The proposed schedule includes "estimated" start dates for the construction activities. In the interest of the Project, the General Contractor reserves the right to alter the sequencing of activities in order to accommodate the project conditions or Authority requirements. It is understood that the Contractor shall be obligated to complete its activities within the specified durations regardless of the actual start date. Contractor agrees to meet or better each duration. The Contractor shall advise the Owner's project manager of any and all automated scheduling software being used on the project.
- G. 3D Contractor Model – computer generated 3D drawings used for coordination, conflict resolution, fabrication, and as-built documentation.
 - 1. Each Contractor will be responsible for producing a model/models to represent the work of the Contractor in accordance with the work breakdown structure to be provided by the General Contractor.
 - 2. If the Contractor does not have the in-house capability to produce the required model/models, the Contractor may utilize the service of an outside entity to provide this service. The Contractor shall, within seven (7) business days of being identified as the approved bidder, provide to the General Contractor and Owner's project manager the name, qualifications and experience history of the proposed BIM Production Modeler. The BIM Production Modeler shall have experience on projects of similar size, scope and complexity. The Owner's project manager has the right to approve any proposed BIM Production Modeler. If the BIM Production Modeler proposed is not approved by the Owner's project manager, then the Contractor shall identify another firm acceptable to the Owner's project manager without any change in cost.
 - 3. All elements must be drawn to scale and shall be a true representation of what is to be installed in the field in all three dimensions.
 - 4. File origin or project insertion point (x,y,z) shall be agreed upon by the project team. Any conflicts that arise due to non-adherence with the insertion point shall be the responsibility of the non-compliant Contractor.
 - 5. File layering convention shall follow the Owner layering standards if applicable.
 - 6. The file naming convention shall be broken down as follows: trade_level_date:
 - 7. Model coordination files will be saved to the project intranet site for access by all trades, General Contractor and the Owner's project manager. The folder structure will contain a "Current Model" file folder and an "Old Model" file folder. It will be the Contractor's responsibility to maintain the appropriate models in the correct file at all times.
 - 8. When an update to a model has been posted each Contractor shall issue a notification via email to each of the other coordination team members notifying them that new information is available. Email, however, shall not be the primary method of delivering model or drawing updates.
 - 9. Working units, unless otherwise specified, shall be in inches.
 - 10. All trades must use a separate color as agreed upon. Colors and/or textures per standards shall be provided by the General Contractor's Modeling Manager.

11. Each Contractor shall maintain their own model files as sole author. Contractors are responsible for providing the team with Navisworks compatible files for their scope of work which will be used for coordination. In some cases separate files will be requested for specific systems within a trade in order to provide the Owner's project manager with greater functionality in the record model. Each Subcontractor is also responsible for compiling and formatting tabular data associated with the equipment, spaces, building systems and other features as directed by the Owner's project manager, and for storing such data in the model and/or in a tabular data base format as directed by the Owner's project manager.
12. In the event the design changes are issued by bulletin which will result in changes in the model/models, and associated data bases, it is the responsibility of the Contractor to make any and all changes required for coordination and compliance with the design. The Contractor may include the cost of modeling and coordination if warranted into their request for change authorization.

H. Ownership:

1. The BIM Files, CADD files, AutoCAD Revit files, TIF files, shop drawings, RFI's, as-built drawings, data bases, etc. (collectively "Project Information"), provided to the Contractor are the Property of the Owner. The Contractor agrees it will keep all project information in strict confidence and will not use on any other project or for any other reason. The Contractor further agrees it will not disseminate the project information to anyone except with a need to know, and will return all project information to Owner when services requiring the project information are complete.
2. In addition to the record documents required by the specifications, the master building information model, data bases, and the subsidiary models provided for design and construction of the project will, upon completion of the project, be property of Owner and the parties agree to provide Owner, as deliverables prior to Final Completion, the most recent version of all files. Upon Owner request the parties will provide the most updated BIM models.

I. Coordination Meetings

1. Each Contractor is required to take part in regular coordination review meetings. The time and place for these meetings will be established by General Contractor. "Big Room" technology, products like Autodesk 360, and/or other products appropriate for remote meeting for engineering and construction projects may be used for these meetings.
2. The purpose of the coordination meeting is to identify and resolve probable interferences between building systems.
3. Contractors shall supply a Modeling Manager or person authorized to act and make decisions on behalf of their organization.
4. If conflicts are identified and a resolution is agreed upon it is the Contractor's responsibility to have the necessary changes made in their model and republish said model to the project intranet site in time for the next meeting unless another timeframe is agreed upon.

J. Coordination Process

1. Step 1: Contractors to identify conflicts between their system model and the base model and resolve with the General Contractor and design team prior to MEP coordination meeting.

2. Step 2: Contractors to identify any required penetrations in architectural and structural elements for their work prior to MEP coordination meeting.
3. Step 3: Contractors to provide system model to the General Contractor. General Contractor will integrate system model with base model in Navisworks to create a "coordination model".
4. Step 4: Contractors and the General Contractor to meet, review, and resolve clashes/conflicts within the coordination model.
5. Step 5: Contractors make changes to their system model per resolutions from MEP coordination meeting.
6. Step 6: Repeat steps 3 through 5 until all clashes/conflicts have been resolved in the coordination model.

1.15 COORDINATION DRAWINGS

- A. Provide a set of HVAC coordination drawings for use in verifying required code clearances (as well as clearances for operation, repair, removal, and testing) of all equipment and for use in coordinating installation of equipment with other trades. Where practical, the CADD layering as established by the A&E team for the construction documents shall be utilized in the preparation of all coordination drawings. Where CADD layering deviates from the A&E team's layering convention, submit the proposed layering system for approval. The CADD layering used shall provide, as a minimum, the flexibility of illustrating trade specific items similar to the established A&E team layering standard.
- B. The intent of the coordination drawings is to identify and resolve installation conflicts prior to fabrication and installation of any MEP trade.
- C. The HVAC Contractor's floor plans shall be the basis for floor plan coordination. The Electrical Contractor's reflected ceiling plans shall be the basis for reflected ceiling plan coordination.
- D. The CADD Drawings prepared by the Architect and Engineer contain representations of certain elements of the Project, and are not necessarily complete, nor are the CADD Drawings comparable or identical to final construction drawings. The Architect and Engineer make no representations or warranties with respect to the accuracy or completeness of the CADD Drawings. The Architect and Engineer do not recommend that the Contractor use the CADD Drawings in connection with the preparation of shop drawings. Should the Contractor choose to do so, however, the Contractor shall carefully review and compare the CADD Drawings with the corresponding final construction drawings to verify their accuracy and identify all discrepancies, differences, and inconsistencies in design, locations, dimensions, scope, and all other respects between the CADD Drawings and the corresponding final construction drawings. The Contractor, shall base the preparation and submission of shop drawings, and in general, shall base the performance of all its obligations with respect to the Project upon the information contained in the final construction drawings and not the CADD drawings. Nothing shall be construed as to relieve the Contractor of any of its obligations (such as, by way of illustration, the obligation to make field measurements or to coordinate drawings) under its contract with respect to the Project.

E. HVAC Coordination Drawings shall be prepared as outlined below.

1. Prepare HVAC Coordination Drawings showing all HVAC work to be installed as part of Section 23 00 00. The Coordination Drawings shall be created using AutoCAD and shall have a scale of not less than 3/8 inch for mechanical/electrical rooms and 1/4 inch for all other areas.
2. The HVAC Coordination Drawings shall show all equipment, pipes, sleeves, inserts, ducts, registers, diffusers and supports. Drawings shall include dimensions and elevation tags for all equipment, devices and material. Under no conditions shall any pipe or conduit pass through any ductwork system
3. After incorporating all trades, resolve any areas of conflicts between trades under the direction of the General Contractor/Construction Manager and submit fully coordinated drawings to the Owner's Representative.
4. Do not install any of this work prior to the preparation and Engineer's review of the final Coordination Drawings. If HVAC work proceeds prior to the final Coordination Drawings, any changes to the HVAC work to correct the interferences and conflicts which result will be made by this Contractor at no additional cost to the Owner.
5. Coordination Drawings are for this Contractor's and Owner's Representative's use during construction and shall not be construed as replacing any shop, "as-built", or Record Drawings required elsewhere in these Contract Documents.
6. Owner's Representative's review of Coordination Drawings shall not relieve this Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

1.16 WARRANTIES

- A. Submit manufacturer's standard replacement warranties for material and equipment furnished under this section. Such warranties shall be in addition to and not in lieu of all liabilities which the manufacturer and the HVAC Subcontractor may have by law or by provisions of the Contract Documents.
- B. All materials, equipment and work furnished under this section shall be guaranteed against all defects in materials and workmanship for a minimum period of one (1) year commencing with the Date of Substantial Completion. Where individual equipment sections specify longer warranties, provide the longer warranty at no additional cost to the owner. Any failure due to defective material, equipment or workmanship which may develop, shall be corrected at no expense to the Owner including all damage to areas, materials and other systems resulting from such failures.
- C. Guarantee that all elements of each system meet the specified performance requirements as set forth herein or as indicated on the drawings.
- D. Upon receipt of notice from the Owner of the failure of any part of the systems during the guarantee period, the affected parts shall be replaced. Any equipment requiring excessive service shall be considered defective and shall be replaced.

1.17 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. It is the intention of the specifications and drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the drawings, but mentioned in the specifications or vice versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the HVAC Subcontractor or his/her Sub Subcontractors, without additional expense to the Owner.
- B. The drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the site and shall have the approval of the Architect before being installed. The HVAC Subcontractor shall follow drawings, including shop drawings, in laying out work and shall check the drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Architect before proceeding with the installation. The HVAC Subcontractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- C. Any requests for information (RFI) for resolving an apparent conflict or unclarity, or a request for additional detail, shall include a sketch or equivalent description of Contractors proposed solution.
- D. Sizes of ducts and pipes and routing are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the intent and purpose of the drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge.

1.18 INSPECTION OF SITE CONDITIONS

- A. Prior to submission of bid, visit the site and review the related construction documents to determine the conditions under which the Work has to be performed. Send a report, in writing, to the Owner's Representative, noting any conditions which might adversely affect the Work of this section of the specifications.

1.19 SURVEY AND MEASUREMENTS

- A. Base all required measurements, horizontal and vertical, from referenced points established with the Owner's Representative and be responsible for correctly laying out the Work required under this section of the specification.
- B. In the event of discrepancy between actual measurements and those indicated, notify the Owner's Representative in writing and do not proceed with the related work until instructions have been issued.

1.20 DELIVERY, STORAGE AND HANDLING

- A. No materials shall be delivered or stored on site until Shop Drawings have been approved.

- B. All manufactured materials shall delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
- C. Protect materials against dampness. Store off floors, under cover, and adequately protected from damage.
- D. Inspect all equipment and materials, upon receipt at the job site, for damage and conformance to approved shop drawings.

1.21 PROTECTION OF WORK AND PROPERTY

- A. This Contractor shall be responsible for the care and protection of all work included under this section until the completion and final acceptance of this Contract.
- B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.
- C. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen under this section and make good damage thus caused.
- D. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.22 SUPERVISION

- A. Provide a competent Supervisor with a minimum of 10 years of experience in HVAC Construction Supervision who shall be in charge of the HVAC work at the site.

1.23 SAFETY PRECAUTIONS

- A. Life safety and accident prevention shall be a primary consideration. Comply with all of the safety requirements of the Owner and OSHA throughout the entire construction period of the project.
- B. Furnish, place and maintain proper guards and any other necessary construction required to secure safety of life and property.

1.24 SCHEDULE

- A. Construct work in sequence under provisions of Division 01 and as coordinated with the Owner's Representative.

1.25 HOISTING, SCAFFOLDING AND PLANKING

- A. The work to be done under this section of the specifications shall include the furnishing, set-up and maintenance of all derricks, hoisting machinery, cranes, helicopters, scaffolds, staging and planking as required for the work.

1.26 CUTTING AND PATCHING

- A. Include all coring, cutting, patching, and fireproofing necessary for the execution of the work of this section. Structural elements shall not be cut without written approval of the Architect. This Contractor shall be responsible for taking all precautions required to identify hidden piping, conduits, etc. before any core drilling and/or cutting of slabs commences, including X-raying the affected slabs. Provide fire stopping to maintain the fire rating of the fire resistance-rated assembly. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details and be listed by UL or FM.
- B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.
- C. Form all chases or openings for the installation of the work of this section of the specifications, or cut the same in existing work and see that all sleeves or forms are in the work and properly set in ample time to prevent delays. Be responsible that all such chases, openings, and sleeves are located accurately and are of the proper size and shape and consult with the Owner's Representative and all trades concerned in reference to this work. Confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the approval of the Owner's Representative.
- D. Fit around, close up, repair, patch, and point around the work specified herein to match the existing adjacent surfaces and to the satisfaction of the Owner's Representative.
- E. Fill and patch all openings or holes left in the existing structures by the removal of existing equipment that is part of this section of the specifications.
- F. All of this work shall be carefully done by workmen qualified to do such work and with the proper and smallest tools applicable.
- G. Any cost caused by defective or ill-timed work required by this section of the specifications shall be borne by the Subcontractor.
- H. When, in order to accommodate the work required under this section of the specifications, finished materials of other trades must be cut or fitted, furnish the necessary drawings and information to the trades whose materials must be cut or fitted.

1.27 SLEEVES, INSERTS AND ANCHOR BOLTS

- A. Coordinate with other trades the location of and maintaining in proper positions, sleeves, inserts and anchor bolts to be supplied and/or set in place under this section of the specifications. In the event of incorrectly located preset sleeves, inserts and anchor bolts, etc., all required cutting and patching of finished work shall be done under this section of the specifications.

- B. All pipes passing through floors, walls, ceilings or partitions shall be provided with fire stopping to maintain the fire rating of the structure. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details. Provide sleeves for all penetrations where required by the listed detail, for the penetration of all mechanical room floors and where specifically required on the drawings.
- C. Field drilling (core drilling), when required, shall be performed under this section of the specifications, after receipt of approval by the Owner's Representative.
 - 1. When coring cannot be avoided, provide ¼ inch pilot hole prior to coring. When coring through floor or slab, verify location of core on floor below and protect and piping, ductwork, wiring, furniture, personnel, etc., below the location of the core.

1.28 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

- A. Provide all supplementary steel, factory fabricated channels and supports required for proper installation, mounting and support of all equipment and systems provided under this section of the specification.
- B. Supplementary steel and factory fabricated channels shall be firmly connected to building construction in a manner approved by the Owner's Representative, as shown on the drawings, or hereinafter specified.
- C. The type and size of the supporting channels and supplementary steel provided under this section of the specifications shall be determined by the Subcontractor and shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.
- D. All supplementary steel and factory fabricated channels shall be installed in a neat and workmanlike manner parallel to the walls, floors and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.
- E. All supplementary steel including factory fabricated channels, supports and fittings shall be galvanized steel, aluminum, or stainless steel where exposed or subject to rust producing atmosphere and shall be manufactured by Unistrut, H-strut, Powerstrut, ERICO or approved equal.

1.29 HAZARDOUS MATERIALS

- A. Dispose of all hazardous materials in accordance with Federal and State laws. All handling shall conform to EPA requirements. A uniform hazardous waste manifest shall be prepared for all disposals and returned with all applicable signoffs prior to application for final payment. Provide breakout cost for this scope.
- B. Recovered refrigerant shall be recycled by a licensed facility approved by the Owner's Representative.

- C. Removed equipment or fluids containing any hazardous materials such as ethylene glycol, oil, mercury or chromate shall be recycled by a licensed facility approved by the Owner's Representative.
- D. Where it has been identified that asbestos-containing material exists within the scope limits, stop work and notify the University. The University shall remediate as required. Where insulation is removed, provide new insulation (types and thicknesses as specified in this section). Where scope is not defined, provide unit prices with bid for all pipe and duct sizes involved.

1.30 ACCESSIBILITY

- A. All work provided under this section of the specification shall be installed so that parts requiring periodic inspection, maintenance and repair are readily accessible. Work of this trade shall not infringe upon clearances required by equipment of other trades, especially code required clearances to electrical gear. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the Owner's Representative.

1.31 ELECTRICAL WORK

- A. All electrical apparatus and controls furnished, and the installation thereof, as a part of the HVAC work, equipment, and controls shall conform to applicable requirements under Division 26 – Electrical.
- B. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, this contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of this contractor.

1.32 HOUSEKEEPING AND CLEANUP

- A. As work progresses and/or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of Work, remove tools, scaffolding, broken and waste materials, etc., from site.

1.33 COMMISSIONING

- A. The HVAC systems shall be provided with system commissioning by the contractor in accordance with requirements of the State's currently adopted International Energy Conservation Code (IECC). The contractor shall provide commissioning and commissioning plans including preliminary commissioning reports developed by a registered design professional or an approved agency in accordance with the commissioning section referenced above in the International Energy Conservation Code. The same registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion to the professional engineer stamping the HVAC drawings in accordance with the provisions of the code sections.

1.34 PROJECT CLOSEOUT

A. Certificates Of Approval

1. Upon completion of all work, provide certificates of inspections from the following equipment manufacturers stating that the authorized factory representatives have inspected and tested the operation of their respective equipment and found the equipment to be in satisfactory operating condition and installed per the manufacturers installation instructions and requirements.
 - a. Energy Recovery Units
 - b. Make-Up Air Units
 - c. Automatic Temperature Controls
 - d. Central heating and cooling distribution equipment and systems
 - e. Air distribution systems and terminal equipment

B. Construction Observations By The Engineer

1. The engineer shall make progress site visits during construction and one (1) substantial completion (punch list) site visit for determining substantial completion.
2. The Trade Contractors and the General Contractor are required to inspect their own work and make any corrections to the work to comply with the specifications and the contract documents. It is not the responsibility of the engineer to develop lists of incomplete work items.
3. Progress Site Visits:
 - a. The purpose of the progress site visit by the engineer is to observe if the work is proceeding in accordance with the contract documents.
 - b. The engineer will prepare a field report which will note in general the work completed since the last observation visit, work found not to be in accordance with the contract documents and work not corrected since the previous observation visit.

C. Substantial Completion

1. When the Contractor considers the Work under this section is substantially complete, the Contractor shall submit written notice, through the General Contractor, with a detailed list of items remaining to be completed or corrected and a schedule of when each remaining work item will be completed. Should the engineer determine the list of remaining work does not constitute substantial completion the engineer will notify the Architect and/or Owner and he will not make a substantial completion site visit.
2. The following items shall be completed prior to the written request for substantial completion site visit:
 - a. Certification of successful operation of all systems.
 - b. Training of the Owner's personnel in the operation of the systems.
 - c. Record Drawings in accordance with the contract specifications.
 - d. Operation and Maintenance manuals.
 - e. Testing reports.
 - f. Balancing reports.
 - g. Manufacturers certificates of approvals.

- h. Emergency contact list for reporting of malfunctioning equipment during the warranty period.
 - i. Contractors Project Completion certificate in accordance with the building code requirements.
3. Should the Engineer, during the substantial completion visit, observe that the Work is substantially complete, s/he will provide a written listing of the observed deficiencies referred herein as the Punch List. The Punchlist will provide for a place for the Contractor and General Contractor to sign off and date each item individually indicating that the observed deficiency item has been corrected.
4. Should the Engineer, during the substantial completion site visit, observe that the Work is not substantially complete, s/he will provide, a written list of the major deficiencies and a reason for the work not being considered substantially complete.
5. If the work is found not to be substantially complete then the engineer shall be reimbursed for his time to reobserve the work. A re-observation fee shall be charged to the Contractor through the contractual agreement for any further observations by the engineer.
6. The Contractor shall remedy all deficiencies listed in the punchlist within the time frame required by the contract.

D. Engineers Construction Completion Certification

1. Where required by the applicable code, the Engineers Construction Completion Certification will be issued by NV5 when all life safety and health related issues are complete, all required functional tests are complete and all reports are complete. The following is a minimum listing of the required systems to be tested with reports generated indicating they are complete and ready for use:
 - a. Air and Water Balancing
 - b. Chilled Water Distribution System Start Up
 - c. Pipe Pressure Tests
 - d. Commissioning of Systems
2. There shall be NO outstanding items identified on the punchlist for scope within any of these categories.

E. Final Completion

1. The following items shall be submitted prior to the written request for Final completion:
 - a. Revised Substantial Completion items to be resubmitted in accordance with the review process comments.
 - b. Warranties commencing the date of Substantial completion
 - c. Individual Signed and dated Punchlist acknowledging completion of all punchlist items
2. When the Contractor considers all of the punchlist work items complete, the Contractor shall submit written notice through the General Contractor that all Punchlist items are complete and resolved and the work is ready for final observation site visit. The signature lines for completion of each punchlist item shall be signed by the Contractor indicating the work is complete and signed by the General Contractor indicating s/he has inspected

the work and found it to be complete. Should the Engineer find the work to be finally complete and all Punchlist items are complete the Engineer will make a recommendation to the Architect or Owner. If the Engineer has found the punchlist work to be incomplete during final inspection a written listing of the observed deficiencies will be prepared by the Engineer.

3. If the work is not fully complete then the engineer shall be reimbursed for his time to re-observe the work. A re-observation fee shall be charged to the Contractor through the contractual agreement for any re-observations by the engineer.

1.35 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
- C. Cleaning Conference: Conduct conference at Project site.
 1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- C. Efficiency: Motor efficiency shall meet or exceed the minimum efficiencies listed in the governing energy code, or the efficiencies listed below, whichever is higher.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Energy Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding or separate winding for each speed as indicated on drawings.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. NEMA MG 1 recommends ball bearings for polyphase motors 500 hp and smaller due to their ability to sustain coupling end-play and rotor float. Some smaller integral and fractional polyphase motors might have sleeve bearings for lower cost and quieter operation, especially if direct coupled and not subjected to belted loads. For motor-bearing requirements for specific equipment, specify those requirements in motorized equipment Sections. Coordinate with equipment suppliers for bearing types in smaller motors. Specify bearing-life requirements, according to ABMA 9, in motor-driven equipment Sections.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Bearing life shall be rated for a minimum L10 life of 20,000 hours for pumps and 80,000 hours for fans.
- H. For longer motor insulation life, consider specifying a temperature rise one class below the insulation rating class, e.g., Class F insulation with Class B temperature rise. Many energy-efficient and most premium-efficient motors come standard with Class F insulation and Class B temperature rise to obtain higher service factors and meet energy-efficiency levels.
- I. Temperature Rise: Match insulation rating.
- J. Standard insulation class for general-purpose, open-dripproof motors, of nominal efficiency rating, is Class B; however, many energy- and premium-efficient motors, and those with service factors 1.15 or higher, are built with insulation meeting Class F requirements, especially if designed as "inverter ready" for use with variable frequency controllers. Retain option in first paragraph below unless a higher or lower insulation class is required as a default.
- K. Insulation: Minimum Class F
- L. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- M. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Bearing Protection: Shaft Grounding Rings equal to Type SGR manufactured by Aegis and shall be factory installed on the motor shaft.
 - 5. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.6 STACK-SLEEVE FITTINGS

- 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. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.7 SLEEVE-SEAL SYSTEMS

- 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. Advance Products & Systems, Inc.
 2. CALPICO, Inc.
 3. Metraflex Company (The).
 4. Pipeline Seal and Insulator, Inc: Link-Seal.
 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber links for general service or NBR links for hydrocarbon/petroleum based applications. Interlocking links shall be shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Reinforced plastic or stainless steel.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.8 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.9 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and non-ferrous setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and non-ferrous setscrew.

2.10 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.11 INDUSTRIAL, METAL-CASE, LIQUID-IN-GLASS, PIPE MOUNTED THERMOMETERS

- 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. Flo Fab inc.
 2. Miljoco Corporation.
 3. Palmer Wahl Instrumentation Group.
 4. Tel-Tru Manufacturing Company.
 5. Trerice, H. O. Co.
 6. Weiss Instruments, Inc.
 7. Weksler Glass Thermometer Corp.
 8. Winters Instruments - U.S.
- B. Standard: ASME B40.200.
- C. Case: Cast aluminum, bronze, or cast-aluminum-bronze, 9-inch nominal size unless otherwise indicated.
- D. Case Form: Adjustable angle unless otherwise indicated.
- E. Tube: Glass with magnifying lens and blue or red non-mercury, organic liquid.
- F. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
- G. Window: Glass.
- H. Stem: Bare stainless steel, aluminum or brass of length to suit installation.
- I. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
- J. Accuracy: Plus or minus 1 percent of scale range or one scale division (if no more than 1.5 percent of scale range).

2.12 PIPE THERMOMETER AND TEMPERATURE SENSOR THERMOWELLS

- A. Thermowells:
1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 3. Material for Use with Copper Tubing: Copper nickel, either 90-10 or 70-30.
 4. Material for Use with Steel Piping: Stainless steel.
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, or 1 inch, with ASME B1.1 screw threads to match thermometer.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.13 PRESSURE GAGES

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

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. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Trerice, H. O. Co.
 - l. Watts; a Watts Water Technologies company.
 - m. Weiss Instruments, Inc.
 - n. Weksler Glass Thermometer Corp.
2. Standard: ASME B40.100.
3. Case: Liquid-filled or sealed type; cast aluminum or stainless steel; 4-1/2-inch and 6-inch nominal diameter (depending upon location).
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Stainless steel, rack and pinion with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psig.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Brass or stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

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. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Trerice, H. O. Co.
 - l. Watts; a Watts Water Technologies company.
 - m. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
 3. Case: Liquid-filled or sealed type; cast aluminum 4-1/2-inch nominal diameter with flange and holes for panel mounting located near eye level.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 6. Movement: Stainless steel, rack and pinion, with link to pressure element and connection to pointer.
 7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psig.
 8. Pointer: Dark-colored metal.
 9. Window: Glass.
 10. Ring: Brass or stainless steel.
 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.14 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass (stainless steel for steam); with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device as required to match gage connection size. Include extension for use on insulated piping.
- B. Siphons (for steam only): Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads as required to match gage connection size.
- C. Valves: Brass ball (stainless-steel ball or needle type for steam), with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads as required to match gage connection size.

2.15 TEST PLUGS AND TEST-PLUG KITS

- 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. Flow Design, Inc.
 2. Miljoco Corporation.
 3. Peterson Equipment Co., Inc.

4. Sisco Manufacturing Company, Inc.
 5. Trerice, H. O. Co.
 6. Watts; a Watts Water Technologies company.
 7. Weiss Instruments, Inc.
 8. Weksler Glass Thermometer Corp.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 400 psig at 240 deg F.
- F. Core Inserts: Nordel or EPDM self-sealing rubber.
- G. Test Plug Kits:
1. Furnish one test-plug kit containing two thermometers, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
 2. Low-Range Thermometer: Small, bimetallic insertion type with 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
 3. High-Range Thermometer: Small, bimetallic insertion type with 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
 4. Pressure Gage: Small, Bourdon-tube insertion type with 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
 5. Carrying Case: Metal or plastic, with formed instrument padding.

2.16 CONCRETE MIXTURES

- A. Class F: Normal weight concrete used for exterior slabs on ground and exterior pads.
1. Exposure Class: ACI 318 F2, S0, W1, C0.
 2. Minimum Compressive Strength: 4,500 psi at 28 days.
 3. Maximum w/cm: 0.45.
 4. Minimum Cementitious Materials Content: 540 lb/cu. yd.
 5. Slump Limit: 4 inches, plus or minus 1 inch.
 6. Air Content:
 - a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 7. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.17 EQUIPMENT PLATFORM

- A. Provide custom fabricated steel platform to meet the intent of the roof plan drawings that provide service access to the new roof top equipment (3 feet high).
- B. All materials shall be provided to be erected by contractor including but not limited to: hardware, framing, posts, stair with handrails, and bar grating for a complete turnkey application.
- C. Platform dimensions, posts locations and fabrication shall be coordinated with mechanical drawing sheet M103-2 that includes weight load criteria, and direction on how supporting post should be placed and designed to coordinate with existing roof structure.
- D. Manufacturer:
 - 1. All Fastener- NexSpan Series or Approved Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 33 for rough-in requirements.

3.4 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 - 11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 - 12. Duct smoke detectors are to be furnished by electrical contractor, installed in duct by mechanical contractor, and wired by electrical contractor.
 - 13. Controls contractor is responsible for final power connections to control panels, dampers, etc, from junction boxes provided by Electrical contractor.
 - 14. Controls contractor is responsible for all wiring required for controls and instrumentation not indicated on the drawings.

3.5 CUTTING AND PATCHING

- A. General: Perform cutting and patching as follows:
 - 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
- C. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- D. Patch finished surfaces and building components using new materials, specified for the original installation and experienced Installers.

3.6 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.
- C. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- D. Particulate Collection:
 - 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 - 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- E. Control odors and mist vapors during the cleaning and restoration process.
- F. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- G. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:

1. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
- H. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

3.7 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Additional Verification:
 1. Perform surface comparison testing or NADCA vacuum test.
 2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- E. Prepare a written cleanliness verification report. At a minimum, include the following:
 1. Written documentation of the success of the cleaning.
 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 3. Surface comparison test results if required.
 4. Gravimetric analysis (nonporous surfaces only).
 5. System areas found to be damaged.
- F. Photographic Documentation: Comply with requirements in Section 013233 "Photographic Documentation."

3.8 MOTOR INSTALLATION

- A. Install equipment in accordance with manufacturer's best recommendations and in accordance with all applicable codes.
- B. Provide code minimum clearance for compliance with NEC work space requirements for live part access and equipment maintenance and servicing.

3.9 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- D. Install rubber packless expansion joints according to FSA-NMEJ-702.
- E. Install grooved-joint expansion joints to grooved-end steel piping per manufacturer's best recommendations.

3.10 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install multiple guides on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.11 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide approximately 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or, where insulated, pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.12 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.13 ESCUTCHEON INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with chrome-plated finish.
 - b. Insulated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall, Ceiling, and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping in Unfinished Service Spaces or Equipment Rooms: One-piece, cast-brass[or split-casting brass] type with rough-brass finish.

2. Escutcheons for Existing Piping:

- a. Insulated Piping: split-casting brass type with polished, chrome-plated finish.
- b. Bare Piping at Wall, Ceiling, and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- c. Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. New Piping: One-piece, floor-plate type.
- 2. Existing Piping: Split-casting, floor-plate type.

3.14 METER AND GAGE INSTALLATION

- A. Install thermowells with socket extending to approximately the center of the pipe with a maximum length of 6-inches for large pipe, and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extensions matching the insulation thickness on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel located near eye level.
- J. Install valve and snubber in piping for each pressure gage for liquids.
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install flow and thermal energy meter elements and components with at least minimum straight lengths of pipe, upstream and downstream according to manufacturer's written instructions for the conditions at the actual sensor location.
- Q. Install any remote flow or thermal-energy meter indicators or BAS interfaces close to the meter served on walls or support brackets in accessible and readable positions.
- R. Install thermometers in the following locations:
 - 1. Inlet and outlet of system in each mechanical room
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.
 - 4. Inlet and outlet of each hydronic coil in air-handling units.
 - 5. Two inlets and two outlets of each hydronic heat exchanger.
 - 6. Adjacent to each BAS hydronic temperature sensor.
 - 7. Outside-, return-, supply-, and mixed-air ducts of air handlers over 3,500 cfm.
 - 8. Other locations shown on drawings.
- S. Pressure gage sizes:
 - 1. Up to 7 feet above finished floor, provide 4½" diameter gauges.
 - 2. Over 7 feet above finished floors, provide 6" diameter gauges.
- T. Install pressure gages in the following locations:
 - 1. Inlet and discharge of each pressure-reducing and control valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Inlet and outlet of each system in each mechanical room.
 - 4. Inlet and outlet of each strainer.
 - 5. Before strainer and at the suction and discharge of each pump (common gage with individual valves and tubing may be used as detailed on drawings).
 - 6. Before strainer and at the inlet and outlet of each control valve and hydronic coil in air handling units (common gage with individual valves and tubing may be used as detailed on drawings).
 - 7. At locations of BAS hydronic pressure and differential pressure (common gage with individual valves and tubing) sensors.
 - 8. Other locations shown on drawings.
- U. Install test plugs in the following locations:
 - 1. Before strainer, on both sides of the control valve and at the inlet and outlet of each hydronic coil that does not have permanently mounted pressure gages and thermometers.
 - 2. Other locations shown on drawings.

3.15 CONNECTIONS

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

- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.16 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade, and Concrete slabs on or below Grade:
 - a. Piping NPS 4 and Smaller: Galvanized-steel wall sleeves (selected for 1-inch annular clearance) with sleeve-seal system.
 - b. Piping Larger Than NPS 4: Cast-iron or galvanized pipe sleeves (selected for 1-inch annular clearance) with sleeve-seal system.
 - 2. Concrete Slabs above Grade:
 - a. Galvanized-steel-pipe sleeves or stack-sleeve fittings.
 - 3. Interior Partitions:
 - a. Galvanized-steel-pipe sleeves or galvanized-steel-sheet sleeves.

3.17 THERMOMETER SCHEDULE

- A. Pipe mounted thermometers shall be one of the following:
 - 1. Industrial-style, liquid-in-glass type where visible and easily read from the floor.
 - 2. Remote-mounted, metal-case, vapor-actuated type where pipe mounted would not be visible and easily read from the floor.
- B. Thermometers for outside-, return-, supply-, exhaust-, and mixed-air ducts shall be liquid-filled and sealed, bimetallic-actuated type.
- C. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be **[one of]** the following:
 - 1. Liquid-filled or sealed, bimetallic-actuated type.
- D. Thermometer stems shall be of length to match thermowell insertion length.

3.18 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range (minimum) for Chilled-Water Piping: 0 to 120 deg F with 1 deg F maximum divisions.
- B. Scale Range (minimum) for Condenser-Water Piping: 0 to 120 deg F with 1 deg F maximum divisions.

- C. Scale Range (minimum) for Heating, Hot-Water Piping: 30 to 240 deg F with 2 deg F maximum divisions.
- D. Scale Range (minimum) for Dual Temperature Heating Cooling Water Piping: 30 to 240 deg F with 2 deg F maximum divisions.
- E. Scale Range (minimum) for Steam (up to 15 psig) and all Steam-Condensate Piping: 50 to 300 deg F with 2 deg F maximum divisions.
- F. Scale Range (minimum) for Steam Piping (between 15 psig and 225 psig): 50 to 500 deg F with 5 deg F maximum divisions.
- G. Scale Range (minimum) for Outdoor and Exhaust Air Ducts: Minus 20 to plus 140 deg F with 2 deg F maximum divisions.
- H. Scale Range (minimum) for Return Air Ducts: 30 to 100 deg F with 1 deg F maximum divisions.
- I. Scale Range (minimum) for Supply Air Ducts: Minus 20 to 140 deg F with 2 deg F maximum divisions.

3.19 PRESSURE-GAGE SCHEDULE

- A. Pressure gages shall be one of the following:
 - 1. Industrial-grade, sealed, direct-mounted, metal case type where visible and easily read from the floor.
 - 2. Sealed, remote-mounted, metal case type where pipe mounted would not be visible and easily read from the floor.

3.20 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale range for chilled, hot, and dual temperature water piping as well as closed loop condenser water piping shall be 0 psi to an upper range of 1.5 to 2 times the maximum operating pressure of the system (i.e. maximum pressure at the expansion tank plus the pump shut-off head).
- B. Scale range for open condenser water piping on the suction side of the pumps shall be 30 in. Hg (vacuum) to 30 psi unless the cooling tower basins are more than 50 feet above the pump inlet, in which case the scale range shall be 0 to 100 psi.
- C. Scale range for open condenser water piping on the discharge side of the pumps shall be 0 to 160 psi.
- D. Scale range for gravity steam condensate piping shall be 30 in. Hg to 60 psi.
- E. Scale range for pumped steam condensate piping shall be 0 to 100 psi.
- F. Scale range for steam piping shall be 0 psi to an upper range of 1.5 to 2 times the design operating pressure.

3.21 FLOWMETER SCHEDULE

- A. Flowmeters for Water Piping Systems, Including Pumped Steam Condensate: Magnetic, Turbine, or Ultrasonic type as shown on drawings.

3.22 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Water Piping Systems, Including Pumped Steam Condensate: Magnetic, Turbine, or Ultrasonic type as shown on drawings.
- B. Thermal-Energy Meters for Steam Piping System: Vortex-shedding type.

3.23 FIELD QUALITY CONTROL

- A. Replace broken and damaged products using new materials.

3.24 ADJUSTING

- A. After installation, calibrate instruments according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.25 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete.
- B. Notify owner 24 hours prior to commencement of concrete placement.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
 - 1. If a section cannot be placed continuously, provide construction joints.
 - 2. Deposit concrete to avoid segregation.
 - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid included construction joints.
 - 4. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 5. Maintain reinforcement in position on chairs during concrete placement.
 - 6. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 7. Level concrete, cut high areas, and fill low areas.
 - 8. Slope surfaces uniformly so water drains away from building to parking.

END OF SECTION 230000

SECTION 230514 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. DDC: Direct digital control.
- C. EMI: Electromagnetic interference.
- D. LED: Light-emitting diode.
- E. NC: Normally closed.
- F. NO: Normally open.
- G. OCPD: Overcurrent protective device.
- H. PID: Control action, proportional plus integral plus derivative.
- I. RFI: Radio-frequency interference.
- J. VFD: Variable-frequency drive for motor control.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated.
 - 1. Include dimensions and finishes for VFDs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFD indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each VFD from manufacturer.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.
 1. Include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
 - f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS – BASE BID

- A. ABB Drives (Preferred brand alternate)
- B. Allen Bradley
- C. Yaskawa

2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFDs:
 1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. Application: Constant torque and variable torque.
- C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
 7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means: Disconnect means, with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Suitable for starting the NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
4. NC alarm contact that operates only when circuit breaker has tripped.

2.3 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.

5. Overcurrent.
 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.

- c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - 3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
 - 4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (over temperature or overcurrent).
 - d. PID high- or low-speed limits reached.
 - F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
 - 1. Number of Loops: Two.
 - G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFD settings shall be retained within VFD's nonvolatile memory. VFD shall be provided with BACnet communication module for integration with plant controls.
 - 1. Hardwired Points: As indicated on drawings
- 2.4 FILTERING
- A. Output Filtering:
 - 1. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.
- 2.5 ENCLOSURES
- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Other Wet or Damp Indoor Locations: Type 4X.
 - 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.6 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
 - 1. Pilot Lights: Push to test.
 - 2. Selector Switches: Rotary type.
- B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- D. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour meter.
- E. Spare control-wiring terminal blocks; wired.

2.7 Cabling

- A. VFD Cable:
 - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 - 2. Type TC-ER with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground and sunlight- and oil-resistant outer PVC jacket.
 - 3. Comply with UL requirements for cables in Classes I and II, Division 2 hazardous location applications.

2.8 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFD while connected to its specified motor.
 - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

- B. VFDs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- D. Comply with NECA 1.
- E. VFD Output Circuits: Type TC-ER cable with dual tape shield.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.

- C. Connect selector switches and other automatic-control devices where applicable.
 - 1. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFD with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- E. VFDs will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges as required for correct operation of the motor.
- F. Set field-adjustable pressure switches.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

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

END OF SECTION 262923

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Ball valves.
- 2. Butterfly valves.
- 3. Check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP or WSP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated. Data shall include the leakage rate for all valves.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Plastic Valves, Balancing Valves, Pressure Reducing Valves, Safety (Relief) Valves, Automatic Flow Control (Flow-Limiting) Valves, and Strainers: Comply with requirements specified in Section 232116 "Hydronic Piping Specialties"
- B. Triple Duty Valves and Suction Diffusers: Comply with requirements specified in Section 232123 "Hydronic Pumps."
- C. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves."Section 15901 "Control Valves."
- D. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections, only to be used where this will not damage the valve.
 - 6. ASME B31.1 for power piping valves.
 - 7. ASME B31.9 for building services piping valves.
- E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- F. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

- G. Refer to HVAC valve schedules articles for applications, minimum pressure ratings and construction of valves.
- H. Valve Pressure-Temperature Ratings: Not less than indicated or higher if required for system pressures and temperatures.
- I. Valve Sizes: Same as upstream piping unless otherwise indicated.
 - 1. Gear Actuator: For quarter-turn valves 8-inches and larger with position indicator.
 - 2. Handwheel: For valves other than quarter turn valves 6-inches and smaller with memory stops, other than ball valves types.
 - 3. Handlever: For quarter-turn valves 6-inches and smaller with memory stops (unless a chainwheel is needed).
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article
- J. Valves in Insulated Piping:
 - 1. Ball Valves: With 2-inch stem extensions and extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve and memory stops without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: With extended neck.
 - 3. Gate Valves: With rising stem, unless there is no physical space near the location where the valve is installed.
 - 4. Globe Valves: With non-rising stem for manual ATC valves or rising stem, for manual balancing valves, unless there is no physical space near the location where the valve is installed.
- K. Valve Bypass and Drain Connections: MSS SP-45. Drain Valves (all types). Provide hose connection on outlet of all drain valves.

2.2 BALL VALVES (Up to 2-inch, unless shown otherwise on drawings)

- A. Bronze or Brass Ball Valves:
- B. Multi-Piece Brass or Bronze Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.: Apollo Valves
 - c. Crane; Crane Energy Flow Solutions.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Stockham; Crane Energy Flow Solutions.
 - h. Watts; a Watts Water Technologies company.

2. Description:

- a. Standard: MSS SP-110.
- b. Minimum SWP Rating: 125 psig.
- c. Minimum CWP Rating: 400 or 600 psig (as required for the service pressure and temperature listed in the valve tables).
- d. Body Design: 2 or 3-piece.
- e. Body Material: Forged brass or bronze.
- f. Ends: Threaded or soldered (3-piece only with center removed during soldering)..
- g. Seats: RTFE, PTFE or TFE (as listed in the valve tables).
- h. Stem: Brass, bronze or stainless steel (as listed in the valve tables)..
- i. Ball: Stainless steel or chrome-plated brass or bronze (as listed in the valve tables).
- j. Port: Full.
- k. Maximum Leakage: Bubble tight.
- l. Lever: Zinc plated steel with vinyl grip.

C. Steel Ball Valves:

D. Carbon Steel Ball Valves with Full Port and Stainless-Steel Trim:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Conbraco Industries, Inc.; Apollo Valves
 - b. Jamesbury; Metso.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. Minimum SWP Rating: 125 psig
 - c. Minimum CWP Rating: 1000 psig.
 - d. Body Design: 2 or 3-piece.
 - e. Body Material: Carbon steel, ASTM A 216, Type WCB.
 - f. Ends: threaded.
 - g. Seats: PTFE or reinforced PTFE.
 - h. Stem: 316 Stainless steel.
 - i. Ball: 316 Stainless steel.
 - j. Port: Full.
 - k. Maximum Leakage: Bubble tight.
 - l. Lever: Zinc plated steel or stainless steel, with vinyl grip.

2.3 BUTTERFLY VALVES (2-1/2-inch and Up)

A. General Service, Iron, Single-Flange Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bray Controls; a division of Bray International.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Crane Co.; Crane Valve Group.
 - d. DeZurik Water Controls.
 - e. Milwaukee Valve Company
 - f. VSI
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig (up to 12-inch), 150 psig (over 12-inch).
 - c. Operating Temperature Range: Minus 20 deg F to 230 deg F.
 - d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - e. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - f. Seat: EPDM.
 - g. Stem: One- or two-piece stainless steel.
 - h. Disc: Aluminum bronze, nickel plated or coated ductile iron, or stainless steel. (as listed in the valve tables).
 - i. Maximum Leakage: Bubble tight.

2.4 CHECK VALVES

A. Flanged, Globe Type Silent Valves (For Pump Discharge Over 2-inch):

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. APCO Willamette Valve and Primer Corporation.
 - b. DFT Inc.
 - c. Metraflex, Inc.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
2. Description:
 - a. Standard: MSS SP-125 or ASME 16-34.
 - b. Pressure Class: 125, 150, 250, 300 or 600 (as required for the service pressure and temperature listed in the valve tables).
 - c. Operating Temperature Limit: Minimum 250 deg F.
 - d. Body Material: ASTM A 126, gray iron, ductile iron, or steel.
 - e. Style: Globe, spring loaded; body sized to mate to a butterfly valve.
 - f. Mounting: Horizontal or vertical with flow in either direction.
 - g. Ends: Flanged.
 - h. Seat: Bronze or stainless steel.

2.5 CHAINWHEELS

- 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. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, chain guides, attachment brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to valve stems and/or handles.
 - 3. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve. Include zinc or epoxy coating.
 - 4. Chain: Hot-dip, galvanized steel or stainless steel, of size required for the sprocket rim and valve assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install shutoff duty valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Install silent check valve at each pump discharge (or triple duty valve if allowed) and swing check valves elsewhere as required to control flow direction and as detailed on the drawings.
- C. Install manual balancing and automatic flow limiting valves where indicated on the drawings and details.

- D. Drain valves shall be one of the type listed for isolation in the valve table for each piping system. Provide drain connections at all equipment and all low points in the piping systems to allow for complete drainage. Drain connections shall have full size threaded hose end connections with cap/plug. For piping up to 2-inch, provide minimum ½-inch valves. For piping between 2 and 6-inch, provide minimum ¾-inch valves. For piping between 6 and 12-inch, provide minimum 1-1/2-inch valves. For piping larger than 12-inch, provide minimum 2-inch valves. Provide owner with 50-feet of premium grade hose for each size drain valve used.
- E. Locate valves for easy access and provide separate support where necessary.
- F. Install valves in horizontal piping with stem at or above center of pipe.
- G. Install valves in position to allow full stem movement.
- H. Install chainwheels on operators for butterfly, gate, and globe valves NPS 3 and larger and more than 90 inches above floor. Extend chains to 60 inches above finished floor and provide tie back to column or wall (wherever possibly) to keep chains out of walkways and service spaces.
- I. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level, or vertical with up-flow only.
 - 2. Silent Check Valves: In horizontal or vertical position, between flanges.
- J. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. If valve applications are not indicated, use the following:
 - 1. Shutoff Service for Hydronic Systems: Ball valves or butterfly valves.
 - 2. Shutoff Service for Steam and Steam Condensate Systems: Gate valves, high-performance butterfly valves, or ball valves with steam trim.
 - 3. Shutoff Service for Fuel Oil Systems: Ball valves or gate valves.
- C. Select valves with the following end connections:
 - 1. For Copper Tubing, Up to 2-inch: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Steel Piping, Up to 2-inch: Threaded ends.
3. For Steel Piping, Over 2-inch: Flanged ends.
4. For Grooved-End Steel Piping 90 to 210 deg.F: Valve ends may be grooved, other than near steam heat exchangers.

3.5 VALVE SCHEDULES

- A. Valve pressure rating and construction shall be selected from the valve schedule tables for each valve type and system. Note that automatic control valve applications, including pressure independent control valves (PIACV), are also listed, but are furnished by the Section 230923 ATC contractor for installation under this section. Valves pressure rating shall be based on the maximum pressure available under any condition:
1. Water Systems: If not otherwise listed, the minimum pressure shall be the sum of the safety relief valve set point plus the maximum pump shut-off head plus the elevation below the relief valve to the lowest pipe; with a minimum 25% safety margin added. The maximum temperature shall 230°F for all heating systems (unless scheduled higher on the drawings).

VALVE TABLE FOR WATER SERVICES: Maximum 150 psig at 120°F (CHW & CW)						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Minimum Pressure Rating/Class
Ball	To 2"	2 or 3 piece	Isolation or ATC Modulation (with characterized disc)	Brass or Bronze/RTFE	Sweat (3-piece only) or Threaded (2 or 3-piece)	400 psig CWP (Cold Working Pressure) or ANSI Class 150
Butterfly	2½" - 12"	General Service	Isolation or ATC 2-Position	Iron/EPDM	Flanged	200 psig CWP, Bi-directional, dead end service.
Check	2" - 24"	Silent Globe	Pump discharge	Ductile or Cast Iron or Steel /Bronze or Stainless Steel	Flanged	ANSI Class 125 for 150 psig or Class 250 or 150 Steel for 275 psig

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

- B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548 "Vibration Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Pipe hangers, all types.
 2. Metal framing systems.
 3. Fiberglass strut systems.
 4. Pipe stands.
 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers 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 trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel 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.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports (for indoor use only in non-humid environments):
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports (for outdoor use and indoors in humid environments):
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel (indoor use only) or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Application: Where required to support multiple pipes in areas where individual hangers will not fit.
- B. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
 2. Hanger Rod and fittings: Continuous-thread rod, washer, and nuts made of stainless steel.
- B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
 2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

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. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel (indoors only) or stainless steel.
7. Indoor Metallic Coating: Electroplated zinc, hot-dipped galvanized, mill galvanized, in-line, hot galvanized, or mechanically-deposited zinc.
8. Outdoor Plastic Coating: UV resistant PVC or polyurethane epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. Empire Industries, Inc.
 - c. ERICO International Corporation.
 - d. Haydon Corporation; H-Strut Division.
 - e. NIBCO INC.
 - f. PHD Manufacturing, Inc.
 - g. PHS Industries, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with or exceed MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel (indoors only) or stainless steel.
7. Indoor Metallic Coating: Electroplated zinc, hot-dipped galvanized, mill galvanized, in-line, hot galvanized, or mechanically-deposited zinc.
8. Outdoor Plastic Coating: UV resistant PVC or polyurethane epoxy.

2.5 THERMAL-HANGER SHIELD INSERTS

- 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. Carpenter & Paterson, Inc.
 - 2. Clement Support Services.
 - 3. ERICO International Corporation.
 - 4. National Pipe Hanger Corporation.
 - 5. PHS Industries, Inc.
 - 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 7. Piping Technology & Products, Inc.
 - 8. Rilco Manufacturing Co., Inc.
 - 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield.

2.6 FASTENER SYSTEMS

- A. Fasteners shall be suitable for the concrete type and thickness.
- B. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- C. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece UV-resistant plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, designed for roof installation without membrane penetration.

C. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, designed for roof installation without membrane penetration.
2. Base: UV-resistant plastic or stainless-steel.
3. Vertical Members: Two or more stainless-steel, continuous-thread rods.
4. Horizontal Member: Stainless-steel rod with UV-resistant plastic or stainless-steel, roller-type pipe support.

D. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, designed for roof installation without membrane penetration.
2. Bases: One or more; UV-resistant plastic.
3. Vertical Members: Two or more stainless steel channels.
4. Horizontal Member: Stainless steel channel.
5. Pipe Supports: Stainless-steel, clevis-type pipe hangers.

E. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural stainless-steel shapes, continuous-stainless steel thread rods, and rollers, for mounting on permanent stationary roof curb flashed to roofing system.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel (indoors) or stainless steel (outdoors) shapes. For roof mounting, provide curbs flashed to roofing system. Prefabricated curbs may be used, providing they are rated for the loads involved.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

2.10 ROOF WALKWAY/EQUIPMENT PLATFORM ACCESS AND DUCT SUPPORT SYSTEMS

- A. Manufacturers:
1. Allfasteners NEXSPAN2 System
 2. nVENT CADDY
 3. Rooftop Support Systems

- B. Warranty: 10-year limited warranty on pregalvanized to repair or replace any products we found to be structurally defective in material or workmanship.
- C. Layout: Refer to Level 4 drawings (M103-2) for scale dimensions of RTU service access platform, structural loading criteria, and duct supports.
- D. System Requirements:
 - 1. All exposed metallic components and fasteners shall be of the following: 1. Hot dip galvanized coating per ASTM A924/A924M; A 123/A 123M; A 153/A 153M.
 - 2. Support Bases shall be made of recycled rubber or an engineered thermoplastic with appropriate additives for UV protection.
 - 3. All supports shall be comprised of materials that are compatible with commercially available roof membrane materials (i.e. no slip sheets required).
 - 4. All support shall have smooth surfaces and radius edges to avoid "hot spots" on the roof membrane. The support must evenly distribute load to the membrane surface.
- E. Duct and Equipment Supports: Factory fabricated to support exact duct sizes and equipment to be installed
- F. Walkways and Platforms: Provide galvanized slotted metal grating, in configurations as indicated, and tubular handrails where indicated.
 - 1. Grating: Mill-galvanized carbon steel in accordance with ASTM A525, 12-ga, serrated anti-slip surface.
 - 2. Handrail: Galvanized 1-5/8" channel or tube, or approved equal
- G. Accessories:
 - 1. Carbon Steel: Pregalvanized in accordance with ASTM A653
 - 2. Carbon Steel: Hot-dip galvanized in accordance with ASTM A123

2.11 RTU CUSTOM ROOF CURBS

- A. Pre-fabricated roof curbs shall be provided by mechanical contractor based on owner provided RTU and associated shop drawing. Unit base dimensions and height are indicated on mechanical drawings.
- B. Basis of Design Criteria:
 - 1. Overall Weight: 5,000 lbs max, uniformly distributed through RTU base.
 - 2. Overall RTU Dimensions: 203" length x 77" width, to be confirmed with owner RTU submittal.
- C. Pre-fabricated insulated roof curbs to be of prime galvanized G90 steel construction 14, 16, 18 or 20 gauge as required, meeting ASTM A653/653M, with welded corners and seams joined by continuous welds. Insulation to be 2" black fiberglass. Curbs shall be factory installed wood nailer fastened from inside of roof curb. Height to be as indicated on drawings. Top of all roof curbs shall be level, with pitch built into curb when deck slope. Intent of roof curbs is to elevate RTU's above roof for bottom duct connections and horizontal transfer through curb walls.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.

- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

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

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting".
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

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

- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

- a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
 - O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
 - P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
 - Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- 3.7 INSTALLATION OF ROOF WALKWAY/EQUIPMENT PLATFORM ACCESS AND DUCT SUPPORT SYSTEMS
- A. Duct Support Systems
 - 1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducts, and conduit, whether or not all required devices are shown.
 - 2. Accurately locate and align bases with structural support members indicated on plans.
 - 3. Place pre-assembled support on bases and attach framing post to base bracket with 3/8 inch bolts provided and adjust as needed. Support shall be adjustable to maintain existing elevation and slope.
 - B. Walkway and Equipment Platform Access Systems
 - 1. Install substructures at spacing indicated on drawings.
 - 2. Accurately locate and align bases with structural support members indicated on plans.
 - 3. Set legs of substructures into bases as indicated.
 - 4. Layout and fasten grating to substructures.
 - 5. Where handrails are required, installed as follows:
 - a. Install intermediate rails without tightening.
 - b. Make minor adjustments as needed, such as spacing of substructures to accommodate intermediate handrails, and install hold-downs.
 - c. Secure intermediate handrails and install top handrails.
 - C. Provide a factory trained representative of the manufacturer to visit the site while the work is in progress to assure that the installation conforms to the design requirements and manufacturer's installation requirements.
 - D. Install and secure systems and coordinate roof penetrations and flashing with roof construction.
 - 1. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with owner approved roofing contractor.

3.8 ROOF CURBS

- A. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
 - 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 - 2. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with owner approved roofing contractor.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products.
2. Material and Minimum Thickness: Brass, 0.032-inch; stainless steel, 0.025-inch; Aluminum, 0.032-inch; or anodized aluminum, 0.032-inch; and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Location: Labels shall be installed on the normally visible side of equipment.

B. Plastic Labels for Equipment:

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. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.

- i. Marking Services, Inc.
 - j. Seton Identification Products.
 - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 3. Letter Color: Black.
 - 4. Background Color: White.
 - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F. If location may exceed this limit, metal labels shall be used.
 - 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
 - 10. Location: Labels shall be installed on the normally visible side of equipment.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Include on the label (or on a prominently located second label) all required routine maintenance action per manufacturer. Maintenance label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data with a laminated copy securely attached to the equipment casing.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Carlton Industries, LP.
 - 4. Champion America.
 - 5. Craftmark Pipe Markers.
 - 6. emedco.
 - 7. LEM Products Inc.
 - 8. Marking Services Inc.
 - 9. National Marker Company.
 - 10. Seton Identification Products.
 - 11. Stranco, Inc.

- B. Material and Minimum Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Medium.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/2 inch for viewing distances up to 48 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels:
 - 1. Preprinted, color-coded, with lettering indicating service, pipe size, and showing flow direction according to the pipe label schedules in Part 3.
 - 2. Pipe label material shall be rated for at least 30 deg F above the highest temperature of the piping system at the label location.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to fully or partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 3/4-inch for pipes up 1-inch o.d. (including insulation) and 1-inch high for pipes up to 3 inch o.d. (including insulation). For larger pipes, minimum 2-inch high for pipes up to 60-inches away, and proportionately larger lettering for greater viewing distances.
 - 3. Orient labels for easy reading from floor level.
 - 4. Pipe size may be done by as a separate stencil at the contractor's option.

2.4 STENCILS

- A. Stencils for Piping:
 - 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. Brimar Industries, Inc.
 - b. Carlton Industries, LP.
 - c. Champion America.
 - d. Craftmark Pipe Markers.
 - e. Kolbi Pipe Marker Co.
 - f. Marking Seivics Inc.
 - 2. Lettering Size: At least 3/4-inch for pipes up 1-inch o.d. (including insulation) and 1-inch high for pipes up to 3 inch o.d. (including insulation). For larger pipes. minimum 2-inch high for pipes up to 60-inches away, and proportionately larger lettering for greater viewing distances.
 - 3. Stencil Material: Aluminum or Brass.
 - 4. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel in colors complying with the pipe label schedule in Part 3, unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 5. Identification Paint: Exterior, gloss, alkyd enamel or acrylic enamel in colors complying with the pipe label schedule in Part 3, unless otherwise indicated. Paint may be in pressurized spray-can form.
- B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:
 - 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. Brimar Industries, Inc.

- b. Carlton Industries, LP.
 - c. Champion America.
 - d. Craftmark Pipe Markers.
 - e. Kolbi Pipe Marker Co.
 - f. Marking Services Inc.
2. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 48 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Aluminum or brass.
4. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel, black. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, gloss, alkyd enamel or acrylic enamel, white. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- 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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 2. Brady Corporation.
 3. Brimar Industries, Inc.
 4. Carlton Industries, LP.
 5. Champion America.
 6. Craftmark Pipe Markers.
 7. emedco.
 8. Kolbi Pipe Marker Co.
 9. LEM Products Inc.
 10. Marking Services Inc.
 11. Seton Identification Products.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch; stainless steel, 0.025-inch; or aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain, beaded chain, or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

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

1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Carlton Industries, LP.
 4. Champion America.
 5. Craftmark Pipe Markers.
 6. emedco.
 7. Kolbi Pipe Marker Co.
 8. LEM Products Inc.
 9. Marking Seivics Inc.
 10. Seton Identification Products.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches .
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping shall match existing color coding.

- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying the specified paint color-coded bands or rectangles on each piping system.
1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Pipe labels shall be prominently located for easy reading. Locate pipe labels where piping is exposed in normally unoccupied rooms or above ceilings in normally occupied finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 40 feet along each run. Reduce intervals to 20 feet in areas of congested piping and equipment and above ceilings. In finished occupied spaces without ceilings (exposed piping) labels shall be located just before the piping enters the space and just after the piping exits the space and at intervals of 100' within the space.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Identification and Color Schedule:
1. The following color coding shall be used with colors listed for letters and backgrounds:

SCHEDULE OF PIPING IDENTIFICATION		
Service	Legend	Letter on Background Colors
Hot Water Supply	HWS	Yellow
Hot Water Return	HWR	Yellow

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, and HVAC terminal devices. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Tag valves according to system served with no less than 1-1/2-inch diameter tags. If a larger tag is need to accommodate longer abbreviations or number sequences, increase tag size to 2-inch.

2. Valve-Tag Colors: Colors shall match those listed in the Pipe Label Identification Table for each piping system.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Testing and Balancing of all Air Systems.
 - 2. Testing and Balancing of all Piping Systems.
 - 3. Testing and Verification of all Duct Mounted Tube Type Smoke Detectors:
 - a. Pressure drop and thus velocity at minimum zone or system airflow.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NBC: National Balancing Council.
- C. NEBB: National Environmental Balancing Bureau.
- D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- E. TAB: Testing, adjusting, and balancing.
- F. TABB: Testing, Adjusting, and Balancing Bureau.
- G. TAB Specialist: An entity engaged to perform TAB Work, such as the TAB or balancing contractor.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: At least 45 days prior to Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: At least 30 days prior to Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports for all systems and items listed the SUMMARY paragraph above.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NBC, NEBB, SMACNA, or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NBC, NEBB, SMACNA, or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and certified by AABC, NBC, NEBB, SMACNA, or TABB as a TAB technician.
- B. TAB Conference: Meet with Architect/Engineer, Owner's Representative, Construction Manager/General Contractor, BAS Contractor, and Commissioning Authority on approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide ten days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect/Engineer, Owner's Representative or Commissioning Authority.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. 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.

1.7 COORDINATION

- A. Notice: Provide minimum seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and hydronic distribution systems have been satisfactorily completed.

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.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, system flow diagrams and control sequences, equipment design conditions and system outputs.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, fan rotations are in the correct direction, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure correct rotation and absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. 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 reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. 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 Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.
 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Mechanical Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 Recording of Existing Flows

- A. Prior to demolition take and submit water flow readings at pumps, where called on the drawings. After new work is completed and balanced, rebalance the existing pumps to their new or original airflows (as shown).

3.5 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.

- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves to allow for maximum flow when the control valves are open.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation, and set at indicated flow. For pressure independent control valves and automatic flow limiting valves, verify the set flow of each valve matches the design flow for the unit it controls, if it doesn't set valve to the correct flow or, if non-adjustable, report this and BAS contractor will need to replace it.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Verify proper rotation of all pumps.
 8. Check pump-motor load. If motor is overloaded, reduce speed of the variable speed drive (if applicable), throttle main flow-balancing device so motor nameplate rating is not exceeded. If throttling is more than 10 feet of head, the impellor needs to be trimmed.
 9. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.6 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Compensating for Diversity: When the total flow of all hydronic units is more than the indicated flow of the pump, place a selected number of units (closest to the pump) at a no flow with the remainder at maximum-flow condition until the total flow of the units equals the indicated flow of the pump.
- B. After the remote units are balanced within specified tolerances, measure the differential pressure at the most critical terminal unit and coordinate with the BAS contractor adjust the remote differential-pressure sensor set point to ensure that adequate differential pressure is maintained at the most critical unit.
- C. For systems using pressure independent control valves (PIACV) and/or automatic flow limiting valves, the differential pressure sensor set point shall be set-up so that the pressure drop across the most remote valve is no more than 2 psi above the low end of the valves control range.
- D. Balance the remainder of the units within specified tolerances after setting remote units of equal design flow to no flow. When complete, re-open all units.
- E. Record settings and mark all balancing devices.
- F. Report flow rates that are not within plus or minus 10 percent of design.
- G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- H. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first and then balance the secondary circuits.

3.8 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Verify motor has bearing protecting shaft grounding rings installed. Test the manual bypass of the controller to prove proper operation. Test the manual bypass of the controller to prove proper operation and integration with BAS. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.
- C. Verify proper rotation of fans.
- D. Measure entering- and leaving-air temperatures.
- E. Record compressor and fan data.

3.9 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
- B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.

- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Airflow.
 - 3. Air pressure drop.
 - 4. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.11 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, water flow and differential pressure across each pump.
 - 2. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 4. Check the refrigerant charge.
 - 5. Check the condition of filters.
 - 6. Check the condition of coils.
 - 7. Check the operation of the drain pan and condensate-drain trap.
 - 8. Check bearings and other lubricated parts for proper lubrication.
 - 9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.

5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer, such as fan speed being lower than the fans pressure class.
 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.12 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances, unless otherwise required for air pressurization relationships:
1. Cooling-Water Flow Rate: Plus or minus 5 percent.
 2. Condenser Water Flow Rate: Plus or minus 5 percent..

3.13 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare minimum monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration dates.

- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Cooling coil, wet- and dry-bulb conditions.
 - b. Face and bypass damper settings at coils, if applicable.
 - c. Fan drive settings including settings and percentage of maximum pitch diameter.
 - d. Variable Frequency Drive settings.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Water (where applicable) flow rates.
 2. Pipe and valve sizes and locations.
- E. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make, type, and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig with units indicated.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

F. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.

- e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, type, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Amperage at each connection.
 - f. Sheave make, size in inches, and bore.
 - g. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - h. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- I. Air-Terminal/Fan-Coil Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.

- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary air flow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final air flow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

J. Air-Volume Terminal Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Constant or variable volume primary air.
- h. Non-fan, Series Fan Powered, or Parallel fan powered.
- i. Type and model number.
- j. Size.
- k. Fan data and motor type.

2. Test Data (Indicated and Actual Values):

- a. Primary air flow rates in cfm at design (maximum, minimum, and where applicable heating flows).
- b. Fan air flow rate in cfm.
- c. Motor data and final speed.
- d. Total flow per air handling system.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling-unit identification.
- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.
- e. Flow balancing/indication meter type.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.

- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.

3.15 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
 - a. Measure water flow of at least 10 percent of terminals.
 - b. Verify that balancing devices are marked with final balance position.
 - c. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

- 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner's Representative, Construction Manager, and, where applicable the Commissioning Authority.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner's Representative, Construction Manager, and, where applicable the Commissioning Authority.
- 3. Owner's Representative, Construction Manager, and, where applicable the Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED." All "FAILED" measurements shall be rebalanced with a revised report issued at no additional cost to Owner.
- 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

- 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
- 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

- D. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB 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 TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following piping services:
 - 1. Chilled-water piping (Indoors and Outdoors)
- B. Section includes insulating the following HVAC equipment that is not factory insulated:
 - 1. Chillers.
 - 2. Water pumps (all systems except condenser water).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 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, dampers, specialties and flanges for each type of insulation.
 - 3. Detail attachment and covering of heat tracing inside insulation.
 - 4. Detail insulation application at pipe expansion joints for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of all fire-rated (fire wrap) insulation materials, all non-fire insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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 agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Insulation materials shall be protected during delivery, storage on site, and use from water, crushing, or other damaging conditions. Any damaged insulation shall be replaced with new.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements PART 3 articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process. Foam insulation material shall have a maximum water vapor transmission rate of 0.06 perm-in when tested in accordance with ASTM E96. and shall contain no PBDE's (polybrominated diphenyl esters).
- D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Insulation shall comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials. Flame spread rating shall be 25 or less and smoke development rating shall be 50 or less as tested by ASTM E 84 for up to 2-inch thickness. The minimum R-value shall be 4.0 (per inch) at 75°F.
 - 1. Products: 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. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, K-FLEX LS.
- E. 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 III with factory-applied FSK aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Kraft paper shall be UL rated with maximum permeance of 0.02 perms. R-values listed assume 25% compression during installation. The minimum R-value based on thickness, shall be:

Thickness	R-value
1-½"	4.2
2"	5.6
3"	8.3

- 1. Products: 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. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.

- F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type with factory-applied FSK aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Kraft paper shall be UL rated with maximum permeance of 0.02 perms. The minimum R-value based on thickness, shall be:

Thickness	R-value
1-½"	6.5
2"	8.6

1. Products: 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. CertainTeed Corp.; Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series.

- G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: 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. Fibrex Insulations Inc.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL jacket. ASJ shall consist of white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. ASJ-SSL jacket shall consist of ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. Thermal conductivity (k-value) shall be no more than 0.27 at 100°F mean temperature as tested in accordance with ASTM C 335.

- H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: 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. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
- I. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- J. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: 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. Aeroflex USA, Inc.; Aeroseal LVOC.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand; H. B. Fuller Company.
 - d. K-Flex USA; K-Flex 720 LVOC Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- K. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Company.
 - d. Mon-Eco Industries, Inc.
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- L. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Company.
 - d. Mon-Eco Industries, Inc.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

M. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: 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. Dow Corning Corporation.
 - b. Johns Manville.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: 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. Foster Brand; H. B. Fuller Company.
 - b. Vimasco Corporation
 - c. Design Polymerics.

2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Company.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: minus 20 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Company.
 - d. Knauf Insulation.
 - e. Mon-Eco Industries, Inc.
 - f. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.3 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. Foster Brand; H. B. Fuller Company.
 - c. Vimasco Corporation.
 - d. Design Polymerics.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Company.
 - d. Mon-Eco Industries, Inc.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. PVC Jacket Flashing Sealants:

1. Products: 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. Childers Brand; H. B. Fuller Company.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: 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. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
 - 1. Products: 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. Childers Brand; H. B. Fuller Company.
 - b. ITW Insulation Systems.
 - c. RPR Products, Inc.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size for round ducts or sheet and roll stock ready for shop or field sizing for rectangular and flat oval ducts.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier: Either 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick polysurlyn.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.

- 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: Minimum 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of either a rubberized bituminous resin on a cross-laminated polyethylene film covered with aluminum-foil facing or a self-adhering double layer aluminum facing with high-density polyethylene base waterproofing membrane. Color shall be white or aluminum as selected by architect.
1. Products: 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. Polyguard Products, Inc.
 - b. MFM Building Products Corp.
 - c. Venture Tape Corp.

2.6 TAPES

- A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: 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. Compac Corporation.
 - b. Ideal Tape Co. Inc. an American Biltrite Company.
 - c. Venture Tape.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: 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. Avery Dennison Corporation.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.

- d. Knauf Insulation.
- e. Venture Tape.
- 2. Width: 2 inches.
- 3. Thickness: 3.7 mils.
- 4. Adhesion: 100 ounces force/inch in width.
- 5. Elongation: 5 percent.
- 6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

- 1. Products: 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. ITW Insulation Systems.
 - b. RPR Products, Inc.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; minimum 0.015 inch thick, minimum 1/2 inch wide with wing seal up to 72-inch diameter or minimum 3/4 inch wide with closed seal over 84-inch diameter.
- 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, minimum 0.020 inch thick, minimum 1/2 inch wide with wing seal up to 72-inch diameter or minimum 3/4 inch wide with closed seal over 84-inch diameter.
- 4. Springs: For over 72" diameter, provide twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

- 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - a. Products: 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) AGM Industries, Inc.
 - 2) GEMCO; CD.
 - 3) Harcast Inc.
 - 4) Midwest Fasteners, Inc.
 - 5) Nelson Stud Welding.
- 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

- a. Products: 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) AGM Industries, Inc.
 - 2) GEMCO; CD.
 - 3) Hardcast Inc.
 - 4) Midwest Fasteners, Inc.
 - 5) Nelson Stud Welding.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, secured in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: 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) AGM Industries, Inc.
 - 2) GEMCO.
 - 3) Midwest Fasteners, Inc.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel; or aluminum, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, secured in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: 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) GEMCO.
 - 2) Midwest Fasteners, Inc.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, secured in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: 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) AGM Industries, Inc.
 - 2) GEMCO.
 - 3) Hardcast Inc.
 - 4) Midwest Fasteners, Inc.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel; or aluminum, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
 6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: 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) AGM Industries, Inc.
 - 2) GEMCO.
 - 3) Hardcast Inc.
 - 4) Midwest Fasteners, Inc.
 - 5) Nelson Stud Welding.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: 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) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.8 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: Minimum 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: Minimum 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. These requirements generally apply to all insulation materials and installation except where more stringent requirements are specified in various Part 2 equipment insulation material paragraphs.
- B. Environmental Requirements: Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- C. Quality Assurance: Insulation materials must be asbestos free, UL listed, and manufactured at facilities certified and registered to conform to ISO 9000 Quality Standard. All insulating products and jackets shall carry flame spread and smoke developed ratings as listed in Part 2 for the location as tested in accordance with ASTM E 84.
- D. Workmanship: All insulation shall be installed by a licensed applicator and applied in accordance with the manufacturer's recommendations. All work shall comply with all applicable federal, state, and local codes including, but not limited to, OSHA. All work shall conform to industry and trade accepted standards for commercial and industrial insulations. Verify that piping, heat trace (by the Division 26 Electrical Subcontractor), and ductwork has been tested (including applicable pressure/leakage tests) before applying insulation materials. Surfaces to be insulated shall be cleaned free of dirt, scale, moisture, oil and grease. No vapor barrier leaks or insulation voids will be accepted. Continue insulation vapor barrier through penetrations except where prohibited by code. All fire rated walls and penetrations shall be sealed with fire stopping. Locate insulation and cover seams in least visible locations. Neatly finish insulation at supports, protrusions, and interruptions. For all systems requiring a vapor barrier seal all terminations including fittings, wall penetrations, and supports with vapor barrier mastic such as Foster 30-65, Childers CP-35 or approved equal. In addition, in brine or chilled water pipe systems vapor seal pipe terminations every four (4) pipe sections, using Foster 30-65, Childers CP-35 or approved equal. Bevel and seal ends of insulation at equipment, flanges, and unions. Where insulation is used over stainless surfaces, the material shall be chlorine free.
- E. Delivery and Storage of Materials
 - 1. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the job site.
 - 2. Deliver insulation, coverings, cements, adhesives coatings etc. to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.
 - 3. Installed insulation that has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.
- F. Piping, including piped equipment:
 - 1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
 - 2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

3. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
 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.
- G. Provide duct and plenum insulation of type(s) indicated in these specifications. Minimum total R-value for each location and duct system shall be as shown on the drawing's Minimum Duct Insulation R-values schedule. R-values shown on drawing schedule may be obtained by adding the individual R-values of both the lining (where shown or used) and external duct insulation.
- H. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- I. Install insulation materials, vapor barriers or retarders, jackets, required for each item of duct system as specified in this specification.
- J. All insulated cooling ducts shall have vapor barriers or retarders.
- K. All insulated outdoor ductwork shall have waterproof jackets.
- L. 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.
- M. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- N. Install multiple layers of insulation with longitudinal and end seams staggered.
- O. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- P. Keep insulation materials dry during application and finishing.
- Q. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- R. Install insulation with least number of joints practical.
- S. Where vapor barrier is indicated (minimum of all cooling and outdoor air ducts as well as exhaust ducts from humidified spaces located outdoors, piping below 100degF), 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.

- T. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- U. 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. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 3 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with at least 2 layers of continuous tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- V. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.
- W. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- X. 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.
- Y. 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.
- Z. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- AA. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- BB. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: 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 Section 078413 "Penetration Firestopping" to maintain firestopping and with appropriate fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Duct: 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.
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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. Insulation shall be used for outdoor ductwork (any thickness) and may be used for indoor ducts that are used for cooling where the thickness is no more than 2-inches.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Concealed Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for at least 75 percent of all sides and bottoms of duct and plenum surfaces and for at least 25 percent coverage of all tops of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts (as specified above) and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied matching jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Exposed Indoor Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent of all sides and bottoms of duct and plenum surfaces and for at least 50 percent coverage of all tops of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts (as specified above) and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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.

3.9 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed 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 mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with minimum 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with minimum 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with minimum 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

A. Insulation with FSK, ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

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: Finishes shall be coordinated with existing colors of systems on site (blue, green, etc.)

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

1. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
- B. Heating Hot Water Supply and Return:
 1. 12" and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.13 DUCT INSULATION SCHEDULE, GENERAL

- A. Insulate indoor and outdoor ducts and plenums to the required insulation thickness to meet the thick of the scheduled R-values listed on the drawing or thicknesses shown on the details, whichever is thicker.
- B. Plenums and Ducts Requiring Insulation (as applicable for the project):
 1. Indoor, concealed supply and outdoor air.
 2. Indoor, exposed supply and outdoor air.
 3. Indoor, concealed return located in unconditioned spaces.
 4. Indoor, exposed return located in unconditioned spaces.
 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 7. Outdoor, concealed supply and return.
 8. Outdoor, exposed supply and return.
- C. Items Not Insulated:
 1. Metal ducts with duct liner of sufficient thickness to comply with the required R-value.
 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.

3.14 OUTDOOR DUCT, FIELD-APPLIED WEATHERPROOF JACKET SCHEDULE

- A. Pre-manufactured outdoor weather proof duct systems may or may not be an acceptable alternative to the following requirements but may be submitted for approval.

- B. Install jackets over all insulation material located outdoors. Installation and sealing shall result in weatherproof systems. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- C. Insulation on the top of flat ducts shall be tapered to prevent water pooling. Minimum listed insulation thickness shall be maintained at lowest point.
- D. If more than one material is listed, selection from materials listed is Contractor's option.
- E. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 66 Inches:
 - 1. Aluminum, Smooth, Corrugated, or Stucco Embossed: Minimum 0.024 inch thick with Z-shaped locking seams.
 - 2. Painted Aluminum, Smooth, Corrugated, or Stucco Embossed: Minimum 0.024 inch thick with Z-shaped locking seams.
 - 3. Self-Adhesive Waterproofing Membrane: Minimum 60-mil- thick self-adhering double layer.
- F. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 66 Inches:
 - 1. Aluminum, Smooth or Stucco Embossed with 1-1/4-Inch- Deep Corrugations: Minimum 0.040 inch thick.
 - 2. Painted Aluminum, Smooth or Stucco Embossed with 1-1/4-Inch- Deep Corrugations: Minimum 0.032 inch thick.
 - 3. Self-Adhesive Waterproofing Membrane: Minimum 60-mil- thick self-adhering double layer.

3.15 INDOOR PIPING, FIELD APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. PVC: 30 mils thick.
- E. Equipment to be Jacketed, Indoors:
 - 1. PVC: 30 mils thick.
- F. Equipment to be Jacketed, Outdoors, Weatherproofed:
 - 1. Aluminum, Smooth, Corrugated, or Stucco Embossed: Minimum 0.024 inch thick with Z-shaped locking seams.

3.16 OUTDOOR PIPING, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. Aluminum, Smooth Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION 230713

SECTION 230920 – DIRECT DIGITAL CONTROLS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

1.3 DEFINITIONS

- A. BAS: Building Automation System.
- B. BMS: Building Management System
- C. DDC: Direct digital control
- D. I/O: Input/output.
- E. MS/TP: Master slave/token passing.
- F. PC: Personal computer.
- G. PID: Proportional plus integral plus derivative.
- H. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - k. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - l. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - m. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - n. Carbon Dioxide: Plus or minus 50 ppm.
 - o. Electrical: Plus or minus 5 percent of reading.

1.5 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all control dampers (not furnished by equipment manufacturers), control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor. These, as well as all actuators furnished with package equipment, all combination smoke/fire dampers furnished and mounted by Division 23 Contractor, all BAS panels and controls, shall be wired by the BAS Contractor.
- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 1. Control dampers and valves.
 2. Blank-off plates for dampers that are smaller than duct size.
 3. Air and water flow monitoring stations.
 4. Sheet metal baffle plates to eliminate stratification.
 5. Location of all sensor wells and tappings in all piping and duct systems.

D. The Electrical Contractor shall provide:

1. All power wiring to HVAC equipment and motors, heat trace, and to junction boxes (for control power) in mechanical rooms as well as above the ceilings where control wiring is needed for terminal units at a spacing of every 100 sq. ft., and where showed on the electrical drawings. Where available, all control power shall be on the standby generator.
2. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS contractor to hardwire to fan shut down and BAS alarm.
3. Firefighter's Override Panel (FOP) with switches and pilot lights for wiring by BAS contractor to provide On-Off-Auto control of smoke control system(s) and air handling unit(s) including opening/closing the appropriate dampers and providing status through the pilot lights.
4. Contact(s) from standby generator(s) for status of power (normal verses standby), day tank(s) and fuel oil pump set(s) for wiring to the control system by the BAS contractor.
5. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWH and kW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS contractor to coordinate this with the electrical contractor.

1.6 CODE COMPLIANCE

- A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or wiring used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code and the Division 26 specifications – whichever is more stringent.
- D. All smoke dampers shall be rated in accordance with UL 555S.
- E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- F. Comply with FCC, Part 68 rules for telephone modems and data sets.
- G. Components used for both HVAC Systems shall be UL-864 listed and labeled. Components used for fire/smoke control shall be supervised and listed for fire alarm service per NFPA. All such control panels shall be located in building life safety electric rooms, coordinate exact locations with the electrical contractor.

1.7 ACTION SUBMITTALS

A. General

1. The shop drawings and submittal data shall include the physical and performance specifications for all equipment, systems and services provided within the scope of the BAS contract. Refer to Sections 230000 for additional requirements.

B. Certification

1. All automatic temperature control shop drawings, product data, and accuracy requirements shall be certified by the BAS manufacturer, the BAS Contractor and the Mechanical. Certification statements shall be signed by a Corporate Officer or other authorized person.

C. Shop Drawing and Submittal Data

1. The shop drawing and submittal shall include but not be limited to the following:
 - a. A flow diagram, a wiring diagram and a complete written sequence of operation for each control subsystem included on this project.
 - b. The location of all HMI, RFC, and other major control equipment requiring coordination with other trades shall be shown on a set of mechanical floor plan shop drawings with all necessary code and access clearances indicated. This set of drawings shall be submitted to the engineer within 30 days of the finalization of the BAS contract.
 - c. BAS architecture schematics and riser diagrams.
 - d. Valve schedule with design and actual pressure drops and Cv ratings.
 - e. Damper schedule.
 - f. Device schedule.
 - g. Panel schedule and locations.
 - h. Data base, point and alarm schedules and acronyms.
 - i. Coordinated composite wiring diagrams and termination details showing control wiring connections for all trades.
 - j. Manufacturers specification data sheets for all control devices and components including complete performance, accuracy, repeatability, dimensions, and serviceability data. Equipment data sheets shall be clearly labeled and cross referenced to the shop drawings.
 - k. Shop drawing and submittal data that has been previously reviewed by the Owner's Representative, corrected by the contractor and resubmitted to the Owner's Representative shall have all changes clearly identified in the form of "clouded" drawings, "clouded" data sheets, and an itemized list of revisions. The resubmittal data shall also include a written response in the form of a cover letter that clearly addresses each review comment.

D. Composite Wiring Diagram

1. The BAS Contractor shall prepare and submit a complete comprehensive composite wiring diagram showing all wiring and connections necessary for the complete control, monitoring and interlocking of all equipment described in this Section. Wiring diagrams, with Owner's Representative's "final review" or "reviewed exceptions noted" stamp properly affixed, for all equipment including but not limited to motor controllers, variable frequency controllers, heat trace systems, domestic water pressure booster pumping systems, water heaters, water chilling units, boilers, air handling units, fans, unit heaters, air terminal units, lighting control panels, main switchgear, motor control centers, generators, fire alarm system, etc. shall be given to the BAS Automatic Temperature Control Subcontractor who, in turn, shall incorporate this data in a complete composite wiring diagram. This diagram shall include all line and low voltage wiring between BAS/automatic temperature control items, and various other equipment referenced

herein, all wired to obtain the control, monitoring, and operational sequence described within this Section and all other Sections of Division 23 and 26.

2. The BAS Contractor shall immediately, upon award of his subcontract, prepare a complete and specific listing of all equipment for which shop drawings, manufacturer's wiring diagrams, and other information is required. This list shall be submitted through normal channels to the Owner's Representative. The Contractor, all Subcontractors, and all applicable equipment manufacturers shall cooperate with the BAS Contractor to expedite the obtaining of all necessary information. If unable to obtain information at the proper time for submitting composite wiring diagram, the BAS Contractor shall advise the Contractor, Architect, and Engineer of the lack of information and the time delay involved. The BAS Contractor shall provide job supervision of the control wiring and final system check-out of all items wired from the composite wiring diagram. Final checkout of the BAS installation shall be performed jointly by a qualified employee of the BAS Contractor and the Contractor.
3. It shall be the responsibility of all applicable equipment manufacturers to provide accurate control wiring diagrams that reflect the actual conditions of this project. "Standard" or "Typical" diagrams that do not accurately reflect the actual conditions of this project will not be acceptable. It shall be the responsibility of all applicable equipment manufacturers to meet all composite wiring diagram requirements and respond to the BAS request for information within 60 days of receipt of request.
4. Each line (wire) and line (wire) termination shall be identified by a termination number or symbol. In addition, each line (wire) termination shall be suitably indexed to identify the termination location of the other end of the line (wire). Wiring diagrams of the simplified "ladder" type shall be shown for each control sequence where applicable. The ladder diagrams and the composite wiring diagrams shall agree in all details.
5. All internal wiring of power panels shall be included in the composite wiring diagram. For such items as motor control centers, equipment control panels, etc., all jumpers added or removed shall be clearly indicated as being "added" or "removed".
6. The composite wiring drawings shall include description of the control, monitoring and sequence of operation. The description shall include complete identification of each item shown (relay, motor controller, etc.), and each item's exact operation shall be related to the control, monitoring and interlock sequence of operation.
7. Upon completion of the composite wiring diagram, the Contractor shall forward two copies of the composite wiring diagram to the Contractor for Division 26 and to any other applicable equipment suppliers. A copy of the transmittal letter shall be forwarded to the Owner's Representative. The Contractor for Division 16 and the other suppliers shall review these diagrams for correctness and/or omissions and shall certify that these diagrams, in regard to their equipment, work, and responsibilities, are correct, or show corrections as required. They shall return one certified copy of the diagrams to the Contractor. After receipt of these certifications, these diagrams shall be corrected (if needed) and certifications and corrected diagrams shall be submitted by the Contractor, along with the automatic temperature control diagrams, in the normal specified manner. The composite wiring diagram shall be returned to the BAS Contractor within thirty days from the date of his submitting them to the above-mentioned parties. If the diagrams are not returned within this time limit, the BAS Contractor shall notify the Owner's Representative, the Engineer, and the Contractor.

E. As Built Documentation

1. The BAS Contractor shall provide "as built" documentation of the complete BAS system showing point to point connections. The documentation shall contain all field engineering and installation modifications to the original submission. Provide any new, updated or revised specification sheets for control devices or components not included in the original submission. The composite wiring diagrams shall be revised as required to accurately reflect "as-built" conditions. The "as-built" documentation shall be submitted with the operating and maintenance manuals, and be certified by the BAS Contractor to accurately reflect "as-built" conditions. During the first year of operation, starting from the date of Owner final acceptance, it shall be the responsibility of the BAS contractor to correct and revise the composite wiring diagrams should it be determined by the Owner the diagrams do not accurately reflect "as-built" conditions.

F. Samples for Verification:

1. For each color required, of each type of thermostat or sensor cover.
2. Within thirty (30) days of an approved controls submittal, provide samples of the controls graphics for all systems being monitored by the BAS for approval by the designer and owner's representative.

1.8 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Qualification Data: For Installer.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- D. Field quality-control test reports.

1.9 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Maintenance instructions and lists of spare parts for each type of control device.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.

- B. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.11 SPECIAL REQUIREMENTS

- A. This Contractor shall provide all necessary wiring necessary for control system specified. No empty conduits will be provided by the Electrical Contractor. Wiring shall be installed in accordance with Division 26. Contractor shall use 120 V circuits provided by the Electrical Contractor (See Electrical Drawings).

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.13 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate smoke and combination smoke fire damper motor and heat voltages and power and position switch requirements with Section 23113 "Metal Ducts and Accessories". All wiring of these devices will be by this Section.
- C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

- D. Coordinate equipment with Section 26 09 13 "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- E. Coordinate equipment with Section 26 24 16 "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- F. Coordinate equipment with Section 26 24 19 "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- G. Coordinate tie in of lighting contactors with Electrical Contractor to allow BAS monitoring and limited control of lighting system.

1.14 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Maintenance Materials: Two thermostat adjusting key(s).

1.15 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

- A. Each Contractor shall thoroughly instruct the representative(s) of the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. Each Contractor shall make arrangements, via the CM as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the periods of time in which they are to be given. The Architect shall be completely satisfied that the representative of the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by each Contractor to the Owner's representative, then each Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the specification has been complied with. All time required for Owner's instruction to satisfy the above requirements shall be included in this Contract. No extra compensation for such instructions will be allowed.
- B. Each Contractor, including but not limited to, the HVAC Contractor, shall submit to the Architect for approval, a bookmarked, in PDF format, electronic copy of all maintenance and operating instructions for the installation, operation, care and maintenance of all equipment and systems. All data and literature furnished shall be specific for the make and model of the equipment furnished. General non-specific catalog data will not be acceptable. Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section such as fans, valves, plumbing fixtures, hot water heaters, boilers, air handling units, etc., shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner through the General Contractor for approval prior to final submission of manuals.
- C. The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited to, the following:

1. Instructional classes on equipment and systems operation for Owner's representative and maintenance personnel, by engineering staff of each Contractor. Minimum of 120 hours of instruction for minimum of (10) people. Instruction shall include:
 - a. Explanation of manual and its use.
 - b. Summary description of the HVAC systems.
 - c. Purpose of systems.

1.16 TRAINING

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel using the BAS acceptance testing documents.
- B. On-site training shall hands-on instruction geared toward the operation and maintenance of the systems as outlined in section 3.10. Prior to training, the necessary training documents, handouts, etc. shall be provided with the training schedule, which shall include as a minimum:
 1. System Overview.
 2. System Software and Operation.
 3. System Access.
 4. Software features overview.
 5. Changing set points and other attributes.
 6. Scheduling.
 7. Editing programmed variables.
 8. Displaying and editing color graphics.
 9. Running reports and trending.
 10. Workstation maintenance.
 11. Application programming.
 12. Operational sequences including start-up, shutdown, adjusting and balancing.
 13. Equipment maintenance.

1.17 WARRANTY

- A. The BAS contractor shall warrant the entire system (parts and labor) for 18 months after successful system acceptance testing is accepted by Owner's Representative. Beneficial use by the Owner may be an alternative method to begin the warrantee period (providing there is a minimum of 12 months left after successful system acceptance testing and system acceptance by Owner's Representative). Note that all control valves have longer warranties as indicated in the control valve specification paragraphs. During the warranty period, the BAS contractor shall be responsible for all software and hardware upgrades and revisions during normal workday schedule, and within 48 hours of notification if solution cannot be resolved via the remote or web-site connection, to provide and maintain complete and workable building control systems.
- B. Updates to the manufacturer's software shall be provided at no charge during the warranty period.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

- A. Manufacturers:
 - 1. Acceptable Vendors:
 - a. Johnson Controls, Inc.; Controls Group.
- B. Controls contractor shall provide new BAS for all new and existing equipment. Existing BAS shall be migrated to new BAS based on construction phasing. The existing Siemens BAS system shall be maintained through construction to keep building systems active. Equipment serving occupied areas shall not be taken offline for extended duration during construction, must be coordinated with owner at beginning of associated phase to coordinate schedule of outage and restoration. Siemens control system will be removed by contractor at completion of new building automation system installation and testing.
- C. Refer to BAS Architecture detail on sheet M601 for description of new and existing controls scope of work. The existing Siemens BAS shall remain active until complete installation, migration and startup is complete to ensure building remains functional through phased/occupied construction. Remove all Siemens hardware at completion of work.
- D. Controls contractor shall provide integration to owner's existing facility building management system. Contractor shall coordinate with owner for complete integration to Greenville Utilities Operations Center JCI head end building management system.

2.2 SYSTEM ARCHITECTURE

- A. General
 - 1. The Building Automation System (BAS) shall consist of Building Network Control Units (BNCU) and associated Input/Output Unit Modules (I/O, as applicable), Custom Application Controllers (CAC), Application Specific Controllers (ASC), and Operator Workstations (OW)/File Server. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN), if applicable, from a single ODBC-compliant database. The BAS shall have the capability to accommodate integration of and to other building sub-systems (fire alarm, security, card access, lighting, etc.) as indicated on the drawings and detailed in the specifications.
 - 2. Level 1 Network Description (BAS Network):
 - a. Level 1, the main backbone of the system, shall be an Ethernet (ISO/IEC 8802-3) LAN/WAN. Building Network Control Units and Operator Workstations/File Server shall connect directly to this network without the need for Gateway devices.

3. Level 2 Network Description (Field Bus Level)

- a. Level 2 of the system shall consist of one or more field buses managed by the Building Network Control Units. The Level-2 field buses may consist of one or more of the following types:
 - 1) An RS-485 proprietary field bus (or “machine bus”) that supports up to 32 Input/Output Units (I/O) directly connected to a Building Network Control Unit. The I/O modules may be mounted within the BNCU or remotely mounted via a single twisted, shielded pair of wires.
 - 2) An RS-485 proprietary token-passing bus that supports a minimum 120 Custom Application Controllers or Application Specific Controllers.
 - 3) ANSI/ATA 878.1 Arcnet: Field bus utilizes RS-485 signaling. Both Custom Application Controllers and Application Specific Controllers may reside on this network bus (minimum of 60 devices).
 - 4) Master-Slave/Token Passing (ANSI/ASHRAE Standard 135-2001, BACnet): Field bus utilizes RS-485 signaling. Both Custom Application Controllers and Application Specific Controllers may reside on this network bus (minimum of 60 devices).
 - 5) EIA-709.1, LonTalk: Field bus utilizing LonTalk FTT-10a network protocol over twisted pair wiring. Both Custom Application Controllers and Application Specific Controllers may reside on this network bus (minimum of 60 devices).

B. BAS Configuration

1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single workstation/file server (10/100 megabits/sec Ethernet). This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.

C. Standard Network Support

1. All BNCUs and Workstations/File Server shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the BNCU’s, Workstations/File Server shall be capable of using standard, commercially available, “off-the-shelf” Ethernet infrastructure components such as routers, switches and hubs. With this design the Owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems department as all devices shall utilize standard TCP/IP components.

D. Remote Communications

1. In addition to the above LAN/WAN architecture support, the same workstation software (front end) must be capable of managing remote systems via both the internet via WEB server capability and standard dial-up phone lines via modem as a standard component of the software.

E. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. The BAS shall be expandable to interoperate with Lighting, Fire, Security and Access Control sub-systems at any time in the future utilizing "Open Protocol" standards such as ASHRAE/ANSI 135-2001 BACnet, EIA-709.1 LonTalk, or Modbus.
3. The system shall use the same application programming language or configuration software application for a given systems communications level controller (i.e. Operator Workstation, Building Network Control Units, Custom Application Controllers, and Application Specific Controllers).

F. Support For Open Systems Protocols

1. The BAS design shall include solutions for the integration of the following "open systems" protocols: ANSI/ASHRAE 135-2001 BACnet, EIA-709.1 LonTalk, Modbus, OPC Client/Server, and digital data communication to third party microprocessors such as any equipment manufacturer's controllers and variable frequency drives (VFDs).
 - a. BACnet: The BAS shall, as a minimum, support the BACnet Interoperable Building Blocks (BIBBS) for Read (Initiate) and Write (Execute) Services as defined in the Data Sharing BIBBS as follows:
 - 1) DS-RP-A, B
 - 2) DS-RPM-A, B
 - 3) DS-WP-A, B
 - 4) DS-WPM-A, B
 - b. LonTalk: The BAS shall support LonTalk communications using FTT-10 transceivers. All communications shall follow LonMark standards utilizing approved Standard Network Variable Types (SNVTs) and Standard Configuration Parameter Types (SCPTs). LonMark components which do not have a standard applicable profile must comply with LonMark standards, and be provided with a XIF file for self-documentation.
2. The system shall also provide the ability to program custom ASCII communication drivers, residing in the BNCU, for communication to third party systems and devices. These drivers shall provide real time monitoring and control of the third party systems.

G. Controller Standby Power Requirements

1. For every controller, regardless of type, that controls any life safety systems, provide an uninterruptible power supply (UPS) system capable of operating the controller and all associated I/O modules, routers, repeaters, etc. for at least 20 minutes.
2. Wire all these devices with standby (not normal) power. Coordinate locations with electrical contractor.

2.3 BUILDING NETWORK CONTROL UNITS (BNCU)

- A. General: Provide Level 1 Building Network Control Units to provide the performance specified in Part 1 of this Section. Each of these panels shall meet the following requirements.
1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based BNCUs to manage the global strategies required by this project.
 2. The BNCUs shall have sufficient memory to support its operating system, database, a minimum of 3 days of buffer (for trending data), and programming requirements with 50% spare capacity.
 3. The BNCUs shall provide communications ports for connection of the Portable Computer and Portable Operators Terminal.
 4. The operating system of the BNCUs shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 5. All BNCUs shall have battery-backed real time clocks.
 6. Data shall be shared between all BNCUs.
 7. Each BNCU shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
- B. Communications: Each Building Network Control Unit shall reside on the same Level 1 inter-network as the Workstations/File Servers. The network shall be on ISO 8802-3 (Ethernet) and support the Internet Protocol (IP). This network shall be provided by the BAS subcontractor and shall communicate with the Owner's network as defined by the Owner's IT department. Each BNCU shall also perform routing to a network of Level 2 Custom Application and Application Specific Controllers.
- C. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used indoors in a conditioned space (heated and cooled) shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 104 F.
 2. Controllers used a non-cooled interior space or outdoors shall be rated for operation at minus 20 F to plus 130 F, provide ventilation and/or heaters sized to meet these conditions.
 3. Controllers used outdoors and/or in wet locations shall be mounted within NEMA 4 type waterproof enclosures.
- D. Serviceability: Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- E. Memory: The Controllers shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

- F. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage. The Controllers shall contain surge protection and not require any external AC power signal conditioning.
- G. BNCU Operator Display: Controller (at least one in each location) shall include an operator display allowing the user to perform basic daily operations tasks on the building automation system. At a minimum this operator display shall:
 - 1. Be installed on the building controller or on the adjacent wall and require no additional power source.
 - 2. Consist of either a one-quarter VGA touch screen with 320 X 240-pixel resolution with adjustable brightness and the contrast or a minimum 2 line by 40 character LCD display with keypad.
 - 3. Be capable of having the same unique user identification and passwords as the associated controller to limit access to the system and operator functions.
 - 4. Display the current state of any input/output point and equipment controller (CAC or ASC) on the network.
 - 5. Give the operator the ability to override the current state of any output point or HVAC equipment controller (CAC or ASC) on the network.
 - 6. Allow the operator to modify the start and stop times of any time-of-day schedule within the system.
 - 7. Provide a visual indication that a system alarm exists.
 - 8. Provide the ability to view and acknowledge alarms that are annunciated at that BNCU.
 - 9. Allow the operator to view custom graphical displays with dynamic status information.
 - 10. Automatically update displayed system information every 10 seconds.

2.4 CUSTOM APPLICATION CONTROLLERS (CAC)

- A. General: Provide Level 2 Custom Application Controllers to provide the performance specified in Part 1 of this Section. Each of these panels shall meet the following requirements.
 - 1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based CACs to manage the local strategies required by this project.
 - 2. The CACs shall provide communications ports for connection of the Portable Computer and Portable Operators Terminal.
 - 3. The CACs shall have sufficient memory to support its operating system, database, a minimum of 3 days of buffer (for trending data), and programming requirements with 50% spare capacity.
 - 4. All CACs shall have battery-backed real time clocks.
 - 5. The operating system of the CACs shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 - 6. Each CAC shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.

- B. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used indoors in a conditioned space (heated and cooled) shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 104 F.
 - 2. Controllers used a non-cooled interior space or outdoors shall be rated for operation at minus 20 F to plus 130 F, provide ventilation and/or heaters sized to meet these conditions.
 - 3. Controllers used outdoors and/or in wet locations shall be mounted within NEMA 4 type waterproof enclosures.
- C. CAC Operator Display: A local operator display (similar to that specified for BNCUs) shall be provided on at least one CAC or BNCU at each control panel location. The operator display shall be provided for interrogating and editing data. A system security password shall be available to prevent unauthorized use of the keypad and display.
- D. Serviceability: Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.
- E. Memory: The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. The Controllers shall contain surge protection and not require any external AC power signal conditioning.

2.5 APPLICATION SPECIFIC CONTROLLERS (ASC)

- A. General: Provide Level 2 ASCs as required for this project. ASCs are microprocessor-based DDC controllers dedicated to control a specific piece of equipment. They shall be fully user programmable, initially set up to provide the specified sequences. Applications are limited to small HVAC equipment such as VAV and CV terminal units (including fan powered), Unit Ventilators, Heat Pumps, Fan Coil Units, etc.
 - 1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 - 2. Each ASC shall contain sufficient I/O capacity (at least 1 spare point of each type), memory (at least 50% spare), and programming flexibility to control the target system and allow for future changes in programs remotely through the front end.
 - 3. The ASCs shall provide communications ports for connection of the Portable Computer and/or Portable Operators Terminal.
- B. Environment: The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used indoors in a conditioned space (heated and cooled) shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 104 F.
 - 2. Controllers used a non-cooled interior space or outdoors shall be rated for operation at minus 20 F to plus 130 F, provide ventilation and/or heaters sized to meet these conditions.

3. Controllers used outdoors and/or in wet locations shall be mounted within NEMA 4 type waterproof enclosures.
- C. Serviceability: Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.
- D. Memory: ASCs shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.
- E. Immunity to Power and Noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.
- F. Transformer: Power supply for the ASCs must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type with all wiring by the BAS subcontractor.

2.6 DISPLAY CONTROLLERS

- A. Display controllers are standalone, touch screen based operator interfaces. The controller shall be designed for flush mounting in a finished space, with a minimum display size of 9 x 9 inches.
- B. Software shall be user programmable allowing for custom graphical images that simulate floor plans, menus, equipment schematics along with associated real time point values coming from any BNCU on the network.
- C. The touch screen display shall contain a minimum of 64 possible touch cells that permit user interaction for changing screens, modifying set points or operating equipment.
- D. Systems that do not offer a display controller as specified shall provide a panel mounted computer with touch screen capability as an alternative.

2.7 COMMUNICATIONS

- A. This project shall comprise of an ethernet network for communications between Building Network Control Units and Workstations/File Servers.
- B. The BAS subcontractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the controls system inter-network.
- C. Communications services over the inter-network shall result in operator interface and value passing that is transparent to the inter-network architecture as follows:
 1. Connection of an operator interface device to any one controller on the inter-network will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the inter-network.

2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the inter-network. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform inter-network value passing.
- D. The time clocks in all controllers shall be automatically synchronized daily and automatically to the campus BMS central timeclock.

2.8 INPUT/OUTPUT INTERFACE (I/O)

- A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.
- B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller. Provide a minimum of 15% spare I/O points of each type for BNCUs and CACs.
- C. Binary (digital) inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.
- D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.
- E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- F. Binary (digital) outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation. The position of the override switches shall be monitored and any point in override shall be highlighted as such in all graphics.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom controllers shall have status lights, a 2-position (auto/manual) switch, and manually adjustable potentiometer for manual override. The position of the override switches shall be monitored and any point in override shall be highlighted as such in all graphics.

2.9 WEB SERVER FUNCTIONALITY

- A. The BAS system on the Ethernet TCP/IP Internet and/or the Owner's Intranet (coordinate availability with the Owner's IT group) shall be setup as a seamless WEB server. The Web server function shall be either built into the BAS hardware or be a separate fully integrated solid state WEB server hardware device. All user entered information (web pages, security, etc.) shall be stored in non-volatile memory. System operational information and clock functions shall be battery-backed or backed up automatically to another device for a minimum of 72 hours.
- B. The WEB server shall have the ability to automatically obtain an IP (Internet Protocol) address using DHCP. Use of static IP addressing shall also be supported. The WEB server shall have the ability to store HTML code and "serve" pages to a web browser. This provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer□, Netscape Navigator□, etc.) to access real-time data from the entire BAS. No additional software shall have to be installed on the client PC for normal operation of the system. An unlimited number of users shall be able to access the WEB server. A minimum of 15 users shall be able to utilize this device at the same time.
- C. Graphics (for all systems) and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.
- D. The WEB server interface shall be capable of password security, including validation of the requesting PC's IP address. All communication with the WEB server shall be encrypted using 128 bit Secure Socket Layer (SSL) technology. The WEB server interface shall allow the sharing of data or information between any controller, or process or network interface (BACnet, LonTalk and TCP/IP) that the BAS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.
- E. Operators with proper security shall be able to override set points, operation schedules, and equipment operation. These changes shall be made graphically within the web browser. A log of system alarms and events shall be able to be viewed from the web browser. Operators with proper security shall be able to acknowledge alarms. System trends shall be able to be selected and viewed. Trends shall be shown graphically with the proper axis scaling automatically selected. Operators with proper access shall be able to configure the web server using their web browser.
- F. To simplify graphic image space allocation, HTML graphic images, if desired, may be stored on any shared network device. The BAS WEB server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. Real-time values shall be updated automatically at least once every 30 seconds (with the option to switch to manual updates from the remote computer).

2.10 SYSTEM SOFTWARE

A. General Description

1. The software architecture must be object-oriented in design, a true 32-bit application suite utilizing Microsoft's OLE, COM, DCOM and ODBC technologies. These technologies make it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the wealth of data available from the BAS.
2. The graphical user interface (GUI)/workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and set point adjustments.
3. Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation on the central campus monitoring network. All information shall be available in graphic or text displays. Graphic displays shall feature visual effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

B. System Database

1. The files server database engine must be Microsoft SQL Server, or another ODBC-compliant, relational database program. This ODBC (Open Database Connectivity)-compliant database engine allows for an Owner to utilize "their" choice of database and due to it's "open" architecture, allows an Owner to write custom applications and/or reports which communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all workstation files including color graphic, alarm reports, text reports, historical data logs, schedules, and polling records.

C. User Interface

1. The BAS graphic user interface software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the BNCU or remote campus workstation software. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

D. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of

capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 250 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.

E. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions. Object names shall not be required to be unique throughout the system. This allows consistency in point naming. For example, each ASC can have an input called Space Temperature and a set point called CFM Set point. The ASC name shall be unique such as VAV for LAB101. Systems requiring unique object names throughout the system will not be acceptable.
2. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the BAS database. The types of template objects supported shall include all data point types (input, output, string variables, set points, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all “child” objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the BAS.

F. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change set points from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:
 - a. Full High Definition (FHD), bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays. As a minimum graphics shall include: all mechanical equipment including each individual air handling unit, fan, chiller, pump, boiler, heat exchanger, etc.; systems of equipment including chilled water system (chillers, pumps, heat exchangers, control valves, etc.), condenser water system (towers, pumps, chillers, heat exchangers, control valves, etc.); hot water system (boilers, heat exchangers, pumps, control valves, etc.); air handling systems (AHUs, associated fans, control dampers, etc.); clean rooms (all controls); animal rooms (all controls), etc.; floor

plans showing equipment locations and visual indication of any rooms in alarm, with point and click selection of any room's system.

- b. A built-in library of objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". Objects shall be set up so that it is easy to visually see the state of the object (such as fan on or off). These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust set points, start or stop equipment, modify PID loop parameters, or change schedules.
- c. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
- d. Graphic panel objects shall be able to be configured with multiple "tabbed" pages allowing an operator to quickly view individual graphics of equipment, which make up a subsystem or system.
- e. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.

G. On-Line Help and Training

- 1. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. Provide an interactive tutorial CD, which will act as on-line training/help for the systems operator.

H. Automatic Monitoring

- 1. The software shall allow for the automatic collection of data and reports from any controller through either a hardwired or webserver communication link. The frequency of data collection shall be completely user-configurable.

I. Alarm Management

- 1. The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
 - a. Alarm management features shall include:
 - 1) A minimum of 20 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.

- 2) Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
 - 3) Automatic printing of the alarm information or alarm report to an alarm printer or report printer.
 - 4) Playing an audible beep or audio (wav) file on alarm initiation or return to normal.
 - 5) Sending an email, text message, or phone call (by text to speech technology) to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email, phone and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI).
2. Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
 - a. Individual alarms shall be configurable for latching or non-latching type. Controls contractor shall coordinate with owner for determination of what alarms are latching versus non-latching.
3. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
4. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.
5. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

J. Custom Report Generation

1. The software shall contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Each workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it will automatically spawn the associated report editor such as MS Word, WordPerfect, MS Excel, or Quattro Pro.
2. Reports can be of any length and contain any point attributes from any controller on the network.
3. The report generator shall have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.
4. It shall be possible to run other executable programs whenever a report is initiated.
5. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

6. Standard Reports: The following standard system reports shall be provided for this project. These reports shall be readily customized to the project by the owner.
 - a. Points in each controller.
 - b. Points in alarm
 - c. Disabled points
 - d. Overridden points
 - e. Operator activity report
 - f. Alarm history log.
 - g. Program listing by controller with status.
 - h. Network status of each controller
 - i. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand for each building meter. Provide an annual (12 month) summary report showing the monthly electrical consumption and peak demand for each meter.
- K. Spreadsheet-style reports: The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to set up each report to display in any text font, color and background color. In addition the report shall be able to be configured to filter data, sort data and highlight data which meets user-defined criteria.
- L. Dynamic Graphical Charting: The operator shall be able to select system values to be charted in real time. A minimum of three values at one time can be selected for each chart. The type of chart (bar, line, 3-D, etc.) shall be user selectable.
- M. HTML Reporting: The above reports shall be able to be run to an HTML template file. This feature will create an HTML "results" file in the directory of the HTML template. This directory can be shared with other computer users, which will allow those users with access to the directory to "point" their web browser at the file and view the report.
- N. Clock Synchronization: The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks; daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable and for leap years.
- O. Scheduling
 1. It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.
 2. Time of day schedules shall be in a calendar style and shall be programmable for a minimum of one year in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.
 3. Each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

4. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
- P. Programmer's Environment: The programmer's environment will include access to a superset of the same programming language supported in the controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software. On the same screen as the program editor, the programming environment shall include dockable debug and watch bars for program debugging and viewing updated values and point attributes during programming. In addition a wizard tool shall be available for loading programs from a library file in the program editor.
- Q. Saving/Reloading: The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.
- R. Data Logging (Trends and Histories): The workstation software shall have the capability to easily configure groups of data points with trend and history logs and display the trend log data. A group of data points shall be created by drag-and-drop method of the points into a folder. The trend and history log data shall be displayed through a simply menu selection. This data shall be able to be saved to file and/or printed. The operator shall be able to define a custom trend and history log for any data in the system. This definition shall include interval, start-time, and stop-time. As a minimum, any point may be recorded at user selected intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, once a month, or for change of value. Trend and history data shall be capable of being selected as either instantaneous at the time of recording or averaged between time intervals. All trends and histories shall start based on the hour. Each trend and history shall accommodate up to a minimum of 64 system objects. The system operator with proper password shall be able to determine how many samples are stored. Trend and history data shall be sampled and stored on the Building Controller and be archived on the hard disk monthly. BAS shall archive histories for a minimum of 18 months and shall prompt operator each January to archive each calendar year's data on a CD. Trend and history data shall be able to be viewed and printed from the operator interface software. Trends and histories shall be viewable in a text-based format and graphically. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages. BAS contractor shall provide setup of custom histories as required for the listed reports.
- S. Audit Trail: The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
- T. Custom Application Programming: Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

1. The language shall be English language oriented and be based on the syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, the programming language can be graphically-based using function blocks as long as blocks are available that directly provide the functions listed below, and that custom or compound function blocks can be created.
 2. A full screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete code from the custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.
 3. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 4. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and to observe any intermediate values and or results. The debugger shall also provide error messages for syntax and execution errors.
 5. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 6. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and xy. The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.
 7. The programming language shall have pre-defined variables that represent clock time, day of the week, and date. Variables that provide interval timing shall also be available. The language shall allow for computations using these values.
 8. The programming language shall have ability to pre-defined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the values of objects in the system.
- U. Demand Limiting: The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter, or from a watt transducer or current transformer attached to the building feeder lines. The demand limiting program shall be based on a predictive sliding window algorithm. The sliding window duration and sampling interval shall be set equal to that of the local Electrical Utility. Control system shall be capable of demand limiting by resetting HVAC system set-points to reduce load while maintaining Indoor Air Quality (humidity, CO2) and comfort control in the space. Input capability shall also be provided for an end-of-billing period indication.
- V. Maintenance Management: The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.
- W. PID Control: A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-wind-up shall be supplied. The algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable with an option for auto-tuning. The set point shall optionally be chosen to be a reset schedule.
- X. Staggered Start: This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts shall be user-selectable.

- Y. System Calculations: Provide software to allow instantaneous power (e.g. KW), flow rates (e.g. GPM) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window KW demand value. Provide an algorithm that calculates energy usage and weather data (heating and cooling degree days). These items shall all be available for daily, previous day, monthly and the previous month.
- Z. Anti-Short Cycling: All binary (digital) output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.
- AA. Fault Tolerant File Server Operation
 - 1. The system shall provide fault tolerant operation in the event of the loss of the CPU, disk drives, or other hardware required to maintain the operational integrity of the system. Operational integrity includes all user interfaces, monitoring of alarm points and access points, and executing access control functions.
 - 2. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

2.11 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. All temperature devices shall use precision thermistors or RTDs accurate to +/- 1 degree F over a range of minus 30 to 230 degrees F. Space temperature sensors shall be accurate to +/- 0.5 degrees F over a range of 40 to 100 degrees F. Outdoor air temperature sensors shall be accurate to +/- 0.7 degrees F over a minimum range of minus 20 to 120 degrees F.
- C. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box. Temperature sensor may be combined with humidity or carbon dioxide sensor in one housing providing it meets the specifications listed herein.
- D. Where manual overrides are required in the sequences for off-hours occupancy, space temperature sensor housings shall feature both an optional means for adjusting the space temperature set point, as well as a push button for selecting after hours operation.
- E. Space sensors shall incorporate either an LED or LCD display for viewing the space temperature, set point and other operator selectable parameters. The sensors shall include built in buttons that allow local temperature set point adjustment. Displays shall be capable of being blanked out for no local readings where specifically requested by the Owner. Coordination location of no display sensor locations with owner during submittal review.
- F. Duct temperature sensors shall incorporate a thermistor bead or RTD embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the AHU or duct area is less than twelve (12) SF. Tube shall be long enough so that the sensor is at least 1/3 of the way into the air stream.

- G. Averaging sensors shall be employed in AHU's or ducts that are twelve (12) SF and larger. The averaging sensor tube must contain at least one thermistor or RTD for every three (3) SF of AHU or duct area. Sensors shall be accurate to +/- 0.5 degrees F over their normal operating temperature range +/- a 20 degree F margin. Example, for a heating/cooling air-handling unit that normally varies between 55 and 100 degrees F, the sensor shall have the stated accuracy over a range of 35 to 120 degrees F.
- H. Immersion sensors employed for measurement of temperature in all chilled, condenser, glycol and hot water applications as well as steam and refrigerant applications shall incorporate a precision thermistor or RTD type sensor. "Smart" sensors (where called for) shall be RTD type and include either an LED or LCD display. Chilled water sensors shall be accurate to +/- 0.5 degrees F over their normal operating temperature range +/- a 20-degree margin. Condenser and hot water sensors shall be accurate to +/-0.5 degrees F over their normal operating temperature range +/- a 20-degree margin. Example, for a hot water system that normally varies between 90 and 200 degrees F, the sensor shall have the stated accuracy over a range of 70 to 220 degrees F. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
- I. Outside Air Temperature Sensors: Utilize precision thermistor or RTD-type units. Sensors shall be designed to withstand the environmental conditions to which they will be exposed. Sensor enclosure shall allow for adequate air flow over the sensing element. Housing shall be NEMA-3R construction as a minimum.
- J. Thermistor Temperature Sensors and Transmitters:
 - 1. Manufacturers:
 - a. Schneider Electric
 - b. BEC Controls Corporation.
 - c. Ebtron, Inc.
 - d. Heat-Timer Corporation.
 - e. I.T.M. Instruments Inc.
 - f. RDF Corporation.
 - 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 - 5. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
 - 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
 - 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Pushbutton.
 - b. Set-Point Indication: LED display.
 - 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

K. RTDs and Transmitters:

1. Manufacturers:
 - a. Scheider Electric
 - b. BEC Controls Corporation.
 - c. MAMAC Systems, Inc.
 - d. RDF Corporation.
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
5. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

L. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:
 - a. Scheider Electric
 - b. BEC Controls Corporation.
 - c. General Eastern Instruments.
 - d. MAMAC Systems, Inc.
 - e. Vaisala.
2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Color: Selected by architect.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F.
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

M. Pressure Transmitters/Transducers:

1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
 - d. Duct Static-Pressure Range: 0- to 5-inch wg.
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

N. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Concealed.
2. Set-Point Indication: Concealed.
3. Color: Selected by architect.

O. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, Metal wire, tamperproof.
3. Adjusting Key: As required for calibration and cover screws.

2.12 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. I.T.M. Instruments Inc.

2.13 CARBON DIOXIDE SENSORS

- A. Manufacturers:
 - 1. Vaisala.
 - 2. Schneider
 - 3. R.E. Technologies
 - 4. Vulcain
 - 5. Honeywell International Inc.
 - 6. MSA Canada Inc.
- B. Provide wall and duct mounted non-dispersive infrared type carbon dioxide sensors where indicated on drawings. Sensors shall have a field selectable 4 to 20 mA or 0 to 10 VDC linearized output signal over a 0-2000 ppm range (set point will normally be between 600 and 1200 ppm). Power requirement shall be 24 VAC or 24 VDC. Units shall operate in an environment of at least minus 20 to 120 degrees F temperature range and 0 to 95% RH. Accuracy shall be +/- 36 ppm at 800 ppm and 68F. Stability shall be 2% over 5 years. Response time shall not exceed 2 minutes. Sensor shall be certified by manufacturer to require calibration no more frequently than once every 5 years. Enclosure shall be an attractive high impact plastic case. Sensors, providing they meet these specifications, shall be as manufactured by Vaisala, R.E. Technologies, Vulcain, Texas Instruments, MSA, or approved equal

2.14 OCCUPANCY SENSOR

- A. Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.15 PRESSURE SENSORS

- A. Air pressure measurements in ranges up to 0 to 10" water column will be accurate to +/- 1% of range using a solid-state sensing element. Select the smallest range applicable to the use of the sensor. Sensors shall be bi-directional for room pressure monitoring. Acceptable manufacturers include Ashcroft Inc., Modus Instruments, Setra and Mamac.
- B. Differential pressure measurements of liquids or steam shall be accurate to +/- 0.5% of range. Housings shall be NEMA 4 rated.
- C. Provide wind baffles for outdoor pressure sensor locations and indoor locations where there can be turbulence

2.16 AIR FLOW MEASURING STATIONS

- A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
 - 1. Manufacturers:
 - a. Air Monitor Corporation.
 - b. Ebtron, Inc.
 - c. Ruskin
 - 2. Casing: Galvanized-steel frame.
 - 3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.
 - 4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.
- B. Outdoor Air
 - 1. Provide thermal dispersion velocity meters using bio-medical grade self-heated thermistor sensors with glass encapsulated thermistor temperature sensors capable of reading airflow between an airflow range of 50 (or lower) to 5,000 fpm with negligible airside pressure drop (no more than 0.12" at 2500 fpm velocity).
 - 2. Coordinate size and location of sensor with manufacturer, AHU/RTU manufacturer, and mechanical contractor to design for a velocity at maximum designed air-flow between 1000 – 1600 FPM to provide a minimum 20 to 1 turn-down (5% of design airflow). If the unit has both minimum and maximum outdoor air intakes, both shall have airflow monitors sized within the above listed velocity range.
 - 3. The electronic module shall be microprocessor-based with an alphanumeric LCD Display. Unit shall be rated for a minimum operating temperature range of minus 20 to 120 degrees F, provide any required if heaters required to meet this minimum operating range. The module shall operate on 24VAC, with an optional 120VAC. The output and

input signals shall be field selectable and linear with field adjustable scales and shall include 0-5VDC, 0-10VDC, 4-20mA, BACnet, or LonTalk as required. Accuracy shall be at least +/- 2% (sensor only) to 3% (overall unit) of actual airflow.

4. Furnish Ebtron GTD116-Pc or Ebtron Air-IQ/GTx-PC (integrated with TAMCO Damper), or equal by Ruskin, or Air Monitor.

C. Supply, Return and Exhaust Air

1. Provide thermal dispersion velocity meters using intrinsically safe bio-medical grade self-heated glass encapsulated thermistor sensors with thermistor temperature sensors.
2. Install units with proper upstream and downstream straight duct runs or, if these are too short flow straighteners shall be used on the inlet as recommended by the manufacturer.
3. The flow stations shall operate over a minimum range of 50 (or lower) to 5000 feet/min with and overall accuracy of $\pm 2\%$ (sensor only) to 3% (overall unit) of reading.
4. The output signal shall be field selectable and linear with field adjustable scales and shall include 0-5VDC, 0-10VDC, 4-20mA, BACnet, or LonTalk as required.
5. Furnish Ebtron GTA116-Pc or equal by Ruskin, or Air Monitor.

2.17 WATER SYSTEM FLOW METERS

A. Manufacturers:

1. Onicon
2. FYI Flow Technology
3. EMCO
4. Approved alternate

- B. Provide where indicated insertion dual turbine flow meters for measurement of liquid flows in pipe sizes above 2" inches. Below 2 1/2" pipe, provide in-line type flow meters with isolation valves and manual bypass.

- C. Install the insertion flow meters with hot tap assembly with depth gauge and shutoff valve to permit removal without process shutdown.

- D. Sensors shall be capable of reading velocities between 0.17 and 20 FPS with 2% accuracy above 0.4 FPS, have local readout, and 4 to 20 mA or 0-10 volt output to the control system. Transmitter shall be integral with flow meter assembly. Sensors shall be as manufactured by ONICON or approved equal.

- E. Contractor shall ensure proper straight lengths of upstream (minimum of 10 pipe diameters) and downstream (minimum 5 pipe diameters), or more if required per manufacturer's recommendations for the location chosen.

- F. Flow meter shall include microprocessor based BTU meter to provide full energy, flow and temperature data both at the controller LCD panel and over BACnet communication interface. Controller shall include analog outputs for flow, energy, and temperature. Meter shall include:

1. NIST traceable meter calibration for entire BTU measurement system and include certification of calibration.
2. Accuracy: +/-0.15°F from 32°F – 200°F

2.18 THERMOSTATS

A. Manufacturers:

1. Scheider Electric
2. Erie Controls.
3. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
4. Heat-Timer Corporation.
5. Sauter Controls Corporation.
6. tekmar Control Systems, Inc.
7. Theben AG - Lumilite Control Technology, Inc.

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 every day of week.
7. Selection features include degree F display, 12- or 24-hour clock, keyboard disable, and remote sensor.
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."

C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

E. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

- F. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- G. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- H. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- I. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.19 HUMIDISTATS

- A. Manufacturers:
 - 1. Vaisala
 - 2. MAMAC Systems, Inc.
 - 3. ROTRONIC Instrument Corp.
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.20 WATER DETECTION SENSORS

- A. Moisture Detector:
 - 1. Manufacturers: Kele and Associates, DiversiTech or approved alternate.
 - 2. Moisture detector is small, electronic control relay for detecting rising water levels, within drain pans, or mechanical rooms. Moisture detector shall alarm when water levels reach 0.43" to prevent damage, from overflow of drain pans or high water levels. Relay shall reset when water levels decrease to 0.31" and relay re-energizes.
 - 3. Relay is normally energized upon powering up and no water is present. When water level reaches the trip point the relay de-energizes for alarming in BAS.
 - 4. Moisture Detector Relay Module (Model LD1-24):
 - 5. Supply Voltage: 24 VAC, 60 Hz
 - 6. Power Consumption: 1 W
 - 7. Cable length: 18-inches

8. Relays Contacts:
 - a. Type: SPDT
 - b. Rating: 2.5A at 24 VDC; 5.0A at 120 VAC
9. Enclosure Rating: Hermetically Sealed
10. Dimensions: 0.87" H x 2.0" W x 1.25" L

B. Condensate Overflow Switch:

1. Manufacturers: Kele and Associates, DiversiTech or approved alternate.
2. Moisture detector is small, inline electronic control relay for detecting clogged condensate drain line. Moisture detector shall alarm when water high level is detected to prevent damage, from overflow of drain pans. Relay shall reset when water levels decrease to open drain and relay re-energizes. Install on drain pan outlet.
3. Relay is normally energized upon powering up and no water is present. When water level reaches the trip point the relay de-energizes for alarming in BAS.
4. Moisture Detector Relay Module (Model SS1):
5. Supply Voltage: 24 VAC, 60 Hz
6. Power Consumption: 1 W
7. Cable length: 18-inches
8. Relays Contacts:
 - a. Type: SPDT
 - b. Rating: 2.5A at 24 VDC; 5.0A at 120 VAC
9. Enclosure Rating: Hermetically Sealed
10. Dimensions: 0.87" H x 2.0" W x 1.25" L

2.21 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.
 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 120-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: 40 to 104 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 12 seconds open, 5 seconds closed.

2.22 CONTROL VALVES

A. Manufacturers:

1. Preferred Alternate: Belimo.
2. Delta P Valve
3. Griswold
4. Honeywell
5. SCHNEIDER.

B. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve no more than the leakage listed in the HVAC valve specification section. Valves shall be pressure independent (PIACV), globe, butterfly (open-closed only), high performance butterfly (open-closed or modulating with Cv at 2/3 open), or characterized ball as listed for the system served and of construction listed in Section 23 20 00 HVAC Piping and Distribution Systems valve specification for the system's fluid and temperature/pressure limits and as listed herein. Valves shall be manufactured by one of the listed manufacturers. All non-pressure independent control valves and actuators shall have a minimum 3 year warranty.

C. The intent is for PIACVs to be used for all modulating 2-way control valves on all water systems. Exceptions would be valves where the PIACV minimum pressure drop is higher than allowed (such as a cooling tower bypass which may have a 3 psi limit). PIACVs shall be used for these systems and where shown on the piping details. Each pressure independent (PI) automatic control valve (ACV) is a two-section valve referred to herein as a PIACV. These valves shall be self-balancing (pressure independent) over a minimum operating range across both sections of the valve assembly of 6 to 45 psid (or higher, to match the pump head, if the pump head is over 105 feet) with the mechanical PI section limiting the differential pressure over the ACV section to provide very stable and accurate control. All mechanical pressure independent automatic control valves and actuators shall have a minimum 5 year parts warranty with the first two years being unconditional.

D. PIACV flow selection shall be adjustable on the valve assembly with a minimum range of +40% above the design flow. PIACVs whose flow rate can't be field selected (fixed flow) shall be selected within in the range of -5% to +10% of the design flow and be provided with replacement flow cartridges if required by the balancing Contractor or engineer. The use of up

to 3 parallel PIACV's to achieve the rated flow shall be permitted providing each is installed with a union and the control of the parallel valves is sequential, either by software with a single output or by individual outputs per valve.

- E. Electronic pressure independent automatic control valves (PIACVs) and actuators using flow meters are only allowed when submitted with a minimum 7-year parts warranty with the first two years being unconditional. In addition, these valves require a full 10 year parts and labor warranty if they experience close-off failure due to wire-draw of the seat. This is due to the fact that with flowmeter control versus mechanical pressure absorption requires the ACV section to absorb the entire pressure drop (up the maximum full rated differential pressure), and, at low flow, this can cause erosion (wire-draw) of the valve seat.
- F. The flowmeter shall be integrated with an ultrasonic flow sensor (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential range of 1 to 50 psig. Contractor shall insure the required six (6) straight inlet pipe diameters are provide for the flowmeter.
- G. The control valve assembly shall incorporate an algorithm to automatically compensate for the glycol concentration and be readable by a local device.
- H. Control valves shall meet the heating and cooling loads specified, operate against the normal expected differential pressure without any shortening of life, and close-off against the maximum differential pressure condition for the application (typically pump shut-off head) with a 25% safety factor. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Two-position (open/close) valves shall be full line sized. Unless specified elsewhere, the maximum pressure drop for modulating water/glycol systems control valves shall be 6 psi for mechanical PIACVs (including both sections) or 4 psi (minimum pressure drop shall be 1 psi) for electronic PIACVs or non-PIACVs (as these will have a separate balancing valve pressure drop). Unless specified elsewhere, the maximum pressure drop for modulating steam control valves shall be 50% of the inlet pressure (7.5 psi for a 15 psig steam system) providing the required equipment inlet pressure is met.
- I. Trim material shall be stainless steel for all steam control valves, electronic PIACVs, and high differential pressure control valves (over 12 psid applications).
- J. Valve actuators shall be electronic direct coupled over the shaft, enabling it to be mounted directly to the valve shaft without the need for connecting linkage. Actuators shall have electronic overload circuitry to prevent damage. Actuators shall have visual position indicators. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Spring shall be capable of easy field change from normally open to normally closed. Actuators shall have an external manual gear release (above 60 in-lb torque, provide manual crank) to allow manual positioning of the valve when the actuator is not powered. Modulating actuators shall be positive positioning and respond to a 2 to 10 VDC or 4 to 20 mA operating range. Actuators on all valves 3" and larger shall provide a position feedback signal indicating valve position wired to the BAS and indicated on the graphics. Outdoor mounted actuators shall have NEMA 4/4X enclosure and shall have same voltage heaters to prevent condensation. Indoor actuators near (within 4 feet) of outdoor air streams shall have NEMA 2 enclosures. Actuators shall be sized for the maximum flow and differential pressure available (such as shut-off head of the associated pump or maximum steam pressure) plus a minimum 25% safety factor. Submit sizing calculations with the shop drawings. Actuators shall be as manufactured by Belimo, Bray, Johnson, Siemens, or approved equal.

- K. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- L. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - 1. Body Style: Wafer.
 - 2. Disc Type: Aluminum bronze.
 - 3. Sizing: 1-psig maximum pressure drop at design flow rate.

2.23 CONTROL AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Ruskin
 - 2. Greenheck
 - 3. Air Balance Inc.
 - 4. TAMCO (T. A. Morrison & Co. Inc.).
 - 5. Vent Products Company, Inc.
- B. Automatic dampers, furnished by the Building Automation Contractor shall be low leakage and include all required linkages, supports, actuators, switches, etc. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor. Control dampers shall be designed for operation in a temperature range of minus 25 and 180 degrees F. Smoke dampers shall be UL 555S rated.
- C. Damper blade width shall not exceed six (6) inches (eight (8) inches for high pressure dampers), unless otherwise noted on drawings. Blade and frame seals shall be replaceable extruded silicone, EPDM, or PVC coated polyester (for low velocity dampers only) on blade edges, TPE or stainless steel compression at jams. Seals and linkages shall provide tight closing, ultra low leakage dampers.
- D. Dampers installed on fan discharges shall be oriented such the blades are perpendicular to the fan shaft, this will minimize pressure drop due to uneven airflow from the fan. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control. Dampers, providing they meet the requirements of these specifications, shall be as manufactured by Ruskin, Arrow, TAMCO (T. A. Morrison), American Warming and Ventilating (AWV), Vent Products, Greenheck, or Johnson Controls. Note that not all manufacturers may make all types of dampers. Model numbers shown are used to indicate the minimum acceptable quality for each type of damper.
- E. Dampers used within four (4) feet of outdoor wall louvers, all penthouse/gooseneck intakes or reliefs, and in aluminum duct systems, shall be aluminum. Other dampers used in galvanized steel duct systems shall be either galvanized steel, or aluminum. Dampers for use in stainless steel duct systems shall be either stainless steel or baked herisite coated aluminum (with no steel or galvanized steel parts).

- F. Provide insulated aluminum dampers for all unducted outdoor air louvers (such as mechanical and generator room ventilation, space relief's, etc.) and on the generator exhaust louvers. Insulated dampers shall be equal to Arrow model AFDTI-25LT, Tamco Series 9000BF, Greenheck model ICD-45, AWW model CR58, or Johnson VD-1252 with thermally broken frame and with blades foam insulated and thermally broken to provide a minimum overall R-value of 1.2. Maximum leakage shall not exceed Class 1A (3.0 cfm/sf at 1 (one) inch w.g. static pressure differential) for all sizes.
- G. Low pressure and smoke control dampers (on up to two (2) inch pressure class ductwork) shall be flat blade or airfoil type designed for a minimum of 2.5 inch differential pressure (all sizes) and up to 2,000 fpm face velocity. These are designated as low pressure dampers. Maximum size of modules for large dampers shall be 4 feet x 4 feet (size could be pressure limited) with an AMCA certified leakage rate not exceeding 3.0 (4.0 for smoke dampers) CFM/sf at one (1) inch w.g. static pressure differential for all sizes. Where larger dampers are needed (either dimension), incorporate mullion supports (same material as damper frame) designed to prevent failure or deformation of the damper assembly up to a differential pressure of four (4) inch w.g. Maximum pressure drop of a fully open 2 foot x 2 foot damper at 1,500 fpm shall not exceed 0.08 inch w.g.
- H. All medium and high pressure control and smoke dampers (on between two (2) inch and four (6) inch pressure class ductwork) shall be airfoil blade type designed for a minimum of the full pressure class rating: four (4) inches for classes 3 and 4 or six (6) inches for class 6 differential pressure (all sizes) and up to 4,000 (2,000 for smoke dampers) fpm face velocity. Maximum size of modules for large dampers shall be 4' x 4' (size could be pressure limited) with an AMCA (UL 555S for smoke dampers). Control dampers shall have Class 1A certified leakage rate not exceeding 3 CFM/sf at one (1) inch w.g. and 8 CFM/sf at four (4) inch w.g. static pressure differential. Smoke dampers shall have Class 1 certified leakage rate not exceeding 8 CFM/sf at four (4) inch w.g. static pressure differential. Where larger dampers are needed (either dimension), incorporate mullion supports (same material as damper frame) designed to prevent failure or deformation of the damper assembly up to a differential pressure of six (6) inch w.g. Maximum pressure drop of a fully open 4' x 4' damper at 2,500 fpm shall not exceed 0.18 inch w.g.
- I. All high pressure (on between four (4) inch and six (6) inch pressure class ductwork) control and smoke dampers shall be airfoil blade type designed and tested for a minimum of 10 inches w.g. differential pressure for control dampers and 6 inches w.g. differential pressure for smoke dampers (all sizes) and up to 4,000 fpm face velocity for control dampers and 2,000 fpm face velocity for smoke dampers. These are designated as high pressure dampers. Maximum size of modules for large dampers shall be 4 feet x 4 feet (size could be pressure limited). Control dampers shall have a maximum leakage rate of 7 cfm/sf at 6" w.g. static pressure differential for all sizes 24" wide or more (Class 2 leakage for UL 555S rated smoke dampers). Where larger dampers are needed (either dimension), incorporate mullion supports (same material as damper frame) designed to prevent failure or deformation of the damper assembly up to a differential pressure of 10 inches w.g. Maximum pressure drop of a fully open 4 feet x 4 feet damper at 2,500 fpm shall not exceed 0.18" w.g.
- J. Aluminum Dampers:
 - 1. Low Pressure Dampers: Frames and single thickness or airfoil blades shall be constructed of not less than 0.080" thick extruded aluminum, type 6063-T5 with minimum four (4) inches deep frame. Linkage hardware shall be installed in frame side and be constructed

- of aluminum and corrosion resistant, zinc & nickel-plated steel (stainless steel for use in stainless steel duct systems). Coordinate with manufacturers for inclusion of thrust collars and other special requirements where vertical blades are required (such as fan discharges). Aluminum low pressure control dampers shall be equal to Greenheck model VCD-40 or 43 or Ruskin Type CD50. Aluminum low pressure smoke dampers shall be equal to Greenheck model SMD-401M or Ruskin type SD50M.
2. Medium Pressure Dampers: Frames and airfoil blades shall be constructed of not less than 0.080" thick extruded aluminum, type 6063-T5 with minimum four (4) inch deep frame. Linkage hardware shall be installed in frame side and be constructed of aluminum and corrosion resistant, zinc & nickel-plated steel (stainless steel for use in stainless steel duct systems). Coordinate with manufacturers for inclusion of thrust collars and other special requirements where vertical blades are required (such as fan discharges). Aluminum medium pressure control dampers shall be equal to Ruskin Type CD50. Aluminum medium pressure smoke dampers shall be equal to Ruskin Type SD50M.
- K. Damper actuators shall be electronic direct coupled over the shaft, enabling it to be mounted directly to the damper shaft with a "V" shaped toothed cradle (to minimize slippage) without the need for connecting linkage. Actuators shall have electronic overload circuitry to prevent damage. Actuators shall have position indicator. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Spring shall be capable of easy field change from normally open to normally closed. Actuators shall have an external manual gear release (above 60 in-lb torque, provide manual crank) to allow manual positioning of the damper when the actuator is not powered. Modulating actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. All actuators on dampers two (2) square feet or larger shall provide a position feedback signal (such as 2 to 10 VDC) indicating damper position, wired to the BAS and indicated on the graphics.
- L. Outdoor mounted actuators shall have NEMA 4/4X enclosure and shall have same voltage heaters to prevent condensation. Indoor actuators near (within 4 feet) of outdoor air streams shall have NEMA 2 enclosures. Actuators for dampers mounted in up to two (2) inch pressure class shall be sized for a minimum 2,500 fpm velocity and two (2) inch differential pressure with a minimum 15% safety factor. Actuator for dampers mounted in higher pressure class ductwork shall be sized for 4,000 fpm velocity and a differential pressure equal to the duct design pressure with a minimum 15% safety factor. Show actuator sizing calculations on submittals. Actuators shall be as manufactured by Belimo, Johnson, Siemens, or approved equal. Actuators for smoke dampers shall meet UL 555S requirements.

2.24 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Section 27 15 00 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats or sensors in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated.
- E. Install automatic dampers according to Section 233300 "Air Duct Accessories."
- F. Install wiring for all automatic control, smoke, and combination fire smoke dampers according to Section 233113 "Mechanical Ducts and Accessories." Provide automated semi-annual testing and documentation program for all smoke and combination fire smoke damper actuators.
- G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- H. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
- I. Install hydronic instrument wells, valves, and other accessories according to Section 232116 Hydronic Piping Specialties."
- J. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."
- K. Install duct volume-control dampers according to Section 233113 "Metal Ducts"

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. All controls wiring is to be run in raceway. No free air conductors.
- B. Install raceways, boxes, and cabinets according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- C. Install building wire and cable according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

- D. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run shall include a separate hot, neutral and ground wire. The ground wire shall terminate at the breaker panel ground. This circuit shall not feed any other circuit or device.
- E. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
- F. Conduit in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
- G. Conduit, in non-finished areas where possible, shall be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
- H. Wires shall be kept a minimum of three (3) inches from all piping.
- I. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
- J. Wire shall not be allowed to run across telephone equipment areas
- K. Install signal and communication cable according to:
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- L. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- M. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 HARDWARE INSTALLATION

- A. Installation Practices for Wiring
 - 1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.

B. Installation Practices for Field Devices

1. Well-mounted sensors shall include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building with a shield to prevent distortion of reading due to wind.

C. Enclosures

1. For all I/O requiring field interface devices, these devices where practical shall be mounted in field interface panels (FIP). The Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. FIP enclosures shall be of steel construction with baked enamel finish, NEMA 1 rated with hinged doors and keyed locks. The enclosures shall be sized for twenty percent spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP shall be to labeled screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification

1. Identify all control wires with labeling tape or sleeves using words, letters, and/or numbers that can be exactly cross-referenced with as-built drawings.
2. All I/O field devices inside FIP's shall be clearly labeled.
3. Junction box covers shall be marked to indicate that they are a part of the BAS system.
4. All enclosures (including controllers), all I/O field devices (except space sensors), all control valves and actuators, all routers and other field devices that are not mounted within FIP's shall be identified with bakelite nameplates. The lettering shall be in white against a black or blue background, be keyed to the as built drawings, and indicate that the device is a control device.

E. Location

1. The location of sensors shall be per mechanical and architectural drawings. Coordinate with installing contractor to provide appropriate straight upstream and/or downstream runs for accurate readings of mixed temperatures or flows.
2. Space humidity, carbon dioxide or temperature sensors shall be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air temperature sensors shall be mounted on the north building face directly in the outside air. Install outdoor temperature and humidity sensors with solar radiation/precipitation shields to minimize the effects of heat radiated from the building or sunlight and from rain.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.
5. Control panels used for smoke control shall be located in building life safety electric rooms, coordinate exact locations with the electrical contractor

3.5 SOFTWARE INSTALLATION

A. General

1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
2. The Contractor shall cooperate with the balancing Contractor and set-up Global Override Commands as required to expedite balancing of air handling and pumping systems. Overrides (to open VAV boxes to desired flow or to open valves) shall be set-up for each system by floor and/or wing so that the total amount of flow can easily be set to equal the desired flow of the central equipment.

B. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by all systems and their respective sequence of operation.

C. Color Graphics: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays for each system and floor plan. Due to limitations on monitor size, some systems may need to be divided into multiple graphics. Provide hot links to all associated graphics for easy switching. For each system or floor plan, the display shall contain the associated points identified in the sequence and submitted point list and allow for set point changes. Color shall be used to highlight conditions that are out of range or in alarm.

D. Reports: The Contractor shall configure a report for each system as well as overall energy usage and demand reports. As built software documentation shall include the following as a minimum:

1. Descriptive point lists.
2. Application program listing.
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.
6. Printouts of all graphics.

3.6 LIGHTING CONTROL INTERFACE

- A. BAS system shall be integrated with lighting contactors to provide:
 - 1. Monitoring: On-off status
 - 2. Control: On-off operation via scheduling or manual control
- B. All lighting and associated wiring by Electrical Contractor. Electrically operated and mechanically held lighting contactors by Electrical Contractor. Provide all wiring and accessories necessary to interface BAS system with lighting contactors.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Point to Point Checkout: Each I/O device (both field mounted and located in FIPs and FOPs) shall be inspected and verified for proper installation and functionality (such as fan status and valve positioning). A pre-functional performance test checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager and submitted (with copy to the Owner's Representative).
 - 6. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 7. Test each system for compliance with sequence of operation.
 - 8. Test software and hardware interlocks.
- C. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 - 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check control valves. Verify that they are in correct direction.
 - 8. Check DDC system as follows:

- a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.8 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.9 ON-SITE ASSISTANCE

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

3.10 INSTRUCTION AND ADJUSTMENT

- A. The Contractor shall provide factory-trained instructor to give full instructions to the owner designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 AM to 5:00 PM weekdays.
- B. Upon completion of the project, the Contractor shall:
1. Fine-tune and "de-bug" all software control loops, routines, programs and sequences of control associated with the control system supplied.
 2. Completely adjust and make ready for use, all transmitters, relays, damper operators, valves, etc., provided under this Section. This Contractor shall furnish copies of complete, detailed, calibrating checkout and commissioning documentation for each controller. Documentation shall list each procedure and shall be signed by the control specialist performing the service.
 3. Furnish a complete set of system operation manual, including standard manufacturers' operating manuals, complete as-built installation diagrams, and complete software hardcopy documentation, as well as a magnetic media back-up.
 4. Provide an on-site training program for the Owner's staff in the operation, troubleshooting, custom programming, and use of the control system. Training shall include two (2) segments, as follows:
 - a. Segment 1 shall include 40 hours of classroom and hands-on training. This segment shall instruct personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment shall give the Owner's representative a working proficiency in the day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).

- b. Segment 2 shall include 24 hours of on-site training. This segment will be geared for the Owner's designated prime operator. An emphasis on overall software management and manipulation shall be made, to allow the prime operator(s) to make control strategy and overall facility and system management changes as required. Attendees shall have attended Segment 1.
- c. All training shall take place at the site and at times mutually agreed to between that ATC Contractor and the Owner. The ATC Contractor shall provide to the Owner's designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule. The ATC Contractor shall provide all training material, reference material and training aids, as required, all as part of his Contract cost.
- d. All training shall be done twice to accommodate two separate groups of trainees.
- e. Training sessions shall, also, include, as a minimum, as follows:
 - 1) Operations / troubleshooting.
 - 2) Custom programming.

END OF SECTION 230920

SECTION 231616 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping.
 - 2. Piping specialties.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, and supports.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Welding certificates.
- C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For motorized gas valves, pressure regulators, and service meters to include in emergency, operation, and maintenance manuals.

1.8 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.10 COORDINATION

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

1.11 NATURAL GAS SERVICE

- A. Gas service, on inlet side of meter, and meter will be installed by Gas Company (Dominion Energy). Contractor shall provide pressure regulator, valves, and piping downstream of the meter connection. Gas Company will provide a new gas service and set a dedicated meter. Coordinate final piping configuration and delivery pressure with Gas Company for connection to new generator. Provide piping and fittings necessary to provide gas service to the generator for a complete and functional system.

PART 2 - PRODUCTS

2.1 ABOVE GROUND, BELOW GRADE PIPES, TUBES, AND FITTINGS (UNDER 1 PSIG)

- A. 2" and Smaller
1. Pipe: ASTM A 53/A 53M, carbon steel, Schedule 40, Type E or S, Grade B
 2. Fittings: Malleable-Iron Threaded ASME B16.3, Class 150, standard pattern.
 3. Joints: Threaded.
 4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 5. 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 sleeve.
- B. 2-1/2" and Larger
1. Pipe: ASTM A 53/A 53M, carbon steel, Schedule 40, Type E or S, Grade B.
 2. Fittings: ASTM A234 Grade WPB/ANSI B16.9, Schedule 40, seamless, carbon steel, welded.
 3. Joints: Welded.
 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 sleeve.

2.2 ABOVE GROUND, BELOW GRADE PIPES, TUBES, AND FITTINGS (OVER 1 PSIG)

- A. 2" and Smaller:
1. Pipe: ASTM A53, Grade B, Type E or S, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel.
 2. Fittings: ASTM A105/ANSI B16.11, 3000 lb forged steel, socket weld.
 3. Joints: Welded.
 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 sleeve.

2.3 PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 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.

2.5 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig

2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in valve General Requirements.
6. Operator: Square head or lug type with tamperproof feature.
7. Pressure Class: 125 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 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; flanged for regulators NPS 2-1/2 and larger.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - b. American Meter Company.
 - c. Richards Industries; Jordan Valve Div.
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. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

12. Atmospheric Vent: Factory- installed, stainless-steel screen in opening if not connected to vent piping.
13. Maximum Inlet Pressure: 10 psig.

2.7 LABELING AND IDENTIFYING

- A. Pipe Labels: Pretensioned or self-adhesive type printed plastic labels. Piping shall be marked "GAS" and be identified with the system pressure. Labels shall be yellow with black lettering.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Inspect natural-gas piping according to the current North Carolina Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- B. Comply with the current North Carolina Fuel Gas Code requirements for prevention of accidental ignition.

3.3 PIPING INSTALLATION

- A. Comply with the current North Carolina Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping indicated to be exposed at right angles or parallel to equipment and fencing. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Locate valves for easy access.
- E. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps. When installing mains and branches which will not be extended, cap each tee or pipe end leak tight. Take branch connections to main from top or side of main.
- F. Install piping free of sags and bends.

- G. Install fittings for changes in direction and branch connections.
- H. Verify final generator configuration and connection location for piping fabrication.
- I. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets, vertical pipe runs, and at generator connection. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 4 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- J. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- K. Connect branch piping from top or side of horizontal piping.
- L. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- M. Do not use natural-gas piping as grounding electrode.
- N. Install strainer on inlet of each line-pressure regulator valve. Install strainer in horizontal position to prevent accumulation of water in strainer basket.

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valves as indicated on the drawings.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.5 PRESSURE REGULATOR INSTALLATION

- A. Install regulators in accordance with manufacturer's instructions.
- B. Regulator shall be accessible for maintenance and protected from fire and mechanical damage. Regulator shall be supported from grade by supports and/or brackets.
- C. Provide unions on both sides of regulators for removal and maintenance.
- D. Provide gas cock for pressure verification

3.6 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.

3.7 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.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas meter according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to grounding system. Coordinate with electrical to ground natural-gas piping in accordance with NFPA 70.
- C. Install piping adjacent to generator to allow generator service and maintenance of requirements.
- D. Connect piping to generator using manual gas shutoff valves and unions. Install valve within 72 inches of enclosure. Install union between valve and enclosure.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to enclosure.

3.9 LABELING AND IDENTIFYING

- A. Comply with NC Fuel Gas Code section 401.5.

- B. Gas piping shall be identified with pipe labels at the beginning, all ends, and at intervals not exceeding 5 feet along its exposed length.
 - 1. Provide label immediately downstream of meter connection and at exterior of generator enclosure.

3.10 PAINTING

- A. Paint exposed, exterior metal piping, valves, service regulators, piping supports, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Gray
- B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Natural gas piping and other service piping pressure testing shall be witnessed by Duke Engineering and Operations prior to system being put into service.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the North Carolina Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 231616

SECTION 232000 - MECHANICAL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Examine all Drawings and all Sections of the Specifications for requirements and provisions affecting the Work of this Section.

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Hot-water heating piping.
 - 2. Makeup-water piping.
 - 3. Condensate-drain piping.
 - 4. Refrigerant pipes and fittings.
 - 5. Refrigerant piping valves and specialties.
 - 6. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data for each piping system for all sizes, including the following:
 - 1. System Identification.
 - 2. Pipe: ASTM number, grade, type, wall thickness, material.
 - 3. Fittings: ASTM number, grade, class, type, wall thickness, material.
 - 4. Joint types.
 - 5. Flanges and Unions: ASME number, grade, class, type, wall thickness, material.
 - 6. Bolts and fasteners, material.
 - 7. Sealants and gaskets: material and rating.
 - 8. Welding and Weld quality control program.
 - 9. Piping pressure testing and test media.
 - 10. Piping flushing and cleaning.
 - 11. Chemical treatment.
 - 12. Refrigerant piping specialties.
- B. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.

3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

C. Shop Drawings: For mechanical piping. Signed and sealed by a professional engineer.

1. Show piping size and 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.
2. Show interface and spatial relationships between piping and equipment.
3. Calculate requirements for expansion compensation for underground piping.
4. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
5. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
 2. Other building services.
 3. Structural members.
- B. Profile Drawings for underground hydronic piping: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.
- C. Qualification Data: For Installer.
- D. Welding certificates.
- E. Source quality-control reports.
- F. Startup performance results.
- G. Field quality-control reports.
- H. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- D. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

- A. Materials shall be protected during delivery, storage on site, and use from water or other damaging conditions. Any damaged materials shall be replaced with new.
- B. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Hot-Water Heating Piping: 200 psig at 250 deg F.
 - 2. Makeup-Water Piping: 80 psig at 150 deg F
 - 3. Condensate-Drain Piping: 150 deg F.
 - 4. Air-Vent Piping: 200 deg F.
 - 5. Safety Valve Inlet and Outlet Piping: Equal to the pressure of the piping system to which it is attached.
- B. Refrigerant requirements:
 - 1. Line Test Pressure for Refrigerant R-134a:
 - a. Suction Lines for Air-Conditioning Applications: 115 psig.

- b. Suction Lines for Heat-Pump Applications: 225 psig.
- c. Hot-Gas and Liquid Lines: 225 psig.
- 2. Line Test Pressure for Refrigerant R-407C:
 - a. Suction Lines for Air-Conditioning Applications: 230 psig.
 - b. Suction Lines for Heat-Pump Applications: 380 psig.
 - c. Hot-Gas and Liquid Lines: 380 psig.
- 3. Line Test Pressure for Refrigerant R-410A:
 - a. Suction Lines for Air-Conditioning Applications: 300 psig.
 - b. Suction Lines for Heat-Pump Applications: 535 psig.
 - c. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube water piping: ASTM B 88, Type L.
- B. Copper Tube for refrigerant piping: ASTM B 280, marked ACR.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- F. Brazing Filler Metals: AWS A5.8/A5.8M.
- G. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150 and 300 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Flanged Unions:
 - 1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
 - 2. Gasket: Fiber asbestos free.
 - 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
 - 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
 - 5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 6. Pressure Rating: Factory test at minimum 400 psig.
 - 7. Maximum Operating Temperature: 330 deg F.
- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 250 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 300 psig.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric Nipples:
 - 1. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

2.6 REFRIGERANT VALVES AND SPECIALTIES

- A. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.

3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

2.7 REFRIGERANTS

- A. ASHRAE 34, R-134a: Tetrafluoroethane.
- B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 and larger, shall be the following:
 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Makeup-water piping installed aboveground shall be the following:
 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Equipment-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- E. Air-Vent Piping:
 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- F. Safety-Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

- G. Refrigerant piping installed aboveground shall be the following:
 - 1. Hot-Gas, Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- H. Chemical treatment systems shall be of same piping materials as systems served.

3.3 VALVE AND SPECIALTY APPLICATIONS

- A. Install service valves for gage taps at inlet and outlet of indoor and outdoor units if they are not an integral part of the equipment.

3.4 PIPING INSTALLATIONS

- A. General
 - 1. Piping shall be cut accurately to measurements established at the jobsite, shall be installed without cold springing, and shall properly clear windows, doors and other openings and electrical gear. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.
 - 2. Piping shall be free of burrs, oil, grease, and other foreign matter.
 - 3. Piping shall be installed to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings.
 - 4. Vent pipes shall be carried through the roof and shall be properly flashed.
 - 5. Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its specified wall, floor, or roof, and shall be cut flush with each surface, except that sleeves through floors and roofs shall extend above the top surface at least 6 inches for proper flashing or finishing. Membrane clamping rings shall be provided where membranes are penetrated. Unless otherwise indicated or required by the sealing system, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be galvanized steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in non-fire rated walls, partitions, and floors shall be sealed as indicated and specified. Metal jackets shall be provided over insulation passing through exterior walls, fire walls, fire partitions, floors, or roofs, shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.16 inch thick aluminum, if smooth, and shall be secured with aluminum or stainless steel bands not less than 3/8 inch wide and not more than 8 inches apart. When penetrating roofs, before fitting the metal jacket into place, a 1/2-inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof.

6. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the backup material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above floor; or when passing through walls above grade, jacket shall extend at least 4 inches beyond each side of the wall.
7. Pipes Passing through Waterproofing Membranes: In addition to the pipe sleeves referred to above, pipes passing through roof or floor waterproofing membranes shall be provided with a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches above the roof or floor. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes passing through roof or floor waterproofing membrane shall be installed through a galvanized steel sleeve. The annular space between pipe and sleeve or conduit and sleeve shall be sealed by a modular mechanical-type sealing assembly (equal to Link-Seal). The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a water-tight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor shall provide sleeves of the proper diameters and gauge.
8. Water Piping
 - a. Unless otherwise indicated, horizontal water piping shall pitch down in the direction of flow with a grade of not less than 1 inch in 100 feet and condensate drain piping shall pitch down in direction of flow with a grade of not less than 1 inch in 30 feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated.
 - b. Unless otherwise allowed in Part 2 Piping and Fittings, or shown on the drawings, connections to equipment shall be made with malleable-iron unions or flanges for steel pipe 2 inches or less in diameter and with flanges or grooved joint couplings for pipe 2-1/2 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric waterway as specified in the Part 2 Piping and Fittings section of this specification. Where the temperature or pressure of the system is beyond the waterway limits, dielectric couplings or other approved methods shall be used. Reducing fittings shall be used for changes in pipe sizes.
 - c. Pipe joints between sections of pipe shall be as listed in the Part 2 Piping and Fittings section in the Schedules for Piping and Fittings tables. Exceptions are pipe and fittings installed in inaccessible conduits or trenches beneath concrete floor slabs or in difficult to access locations such as shafts which shall be welded, soldered or brazed. Some joint types or materials listed may have lower pressure

and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.

- d. Welded joints shall be fusion welded in accordance with ASME B31.1 for all water piping over 160 psig and any other piping where B31.1 is required. All other piping shall be welded in accordance with ASME B31.9 unless otherwise stated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.
- 1) Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.
 - 2) Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.
 - 3) Erection: Where the temperature of the component parts being welded reaches 32 degrees F or lower, the material shall be heated to within 100 degrees F of the system's maximum design temperature for a distance of 3 feet on each side of the weld before welding, and the weld shall be finished before the materials cool to within 200 degrees F of the maximum design temperature.
 - 4) Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with the applicable standard: ASME B31.9 or B31.1.
 - 5) Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.
- e. Flanges and unions shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full-face or self-centering flat ring type. The Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

- f. Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with Teflon (polytetrafluoroethylene) tape or equal. Teflon tape shall be non-toxic and rated for piping systems with temperatures to at least 450 degree F and pressures to at least 1,000 psig. Tape shall be applied the male threads only, and in no case to the fittings.
- g. Soldered and Brazed Joints: Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Changes in direction of piping shall be made with soldered or brazed fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder, or as specified in the Part 2 Piping specification for the system. Cored solder shall not be used. Joints for brazed fittings shall use brazing alloys with strength equal to B-Ag alloy and have a melting point above 1000 degrees F. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Care shall be taken to ensure solder is uniformly (360 degrees) drawn into the joint.

B. Expansion Provisions

- 1. Installation of piping must allow for expansion using offsets, loops, swing joints, expansion joints, etc. as shown and as necessary to prevent undue strain. Take offs from mains to runouts shall not have less than three elbow swing.
- 2. Mains and risers with loops or offsets shall be securely anchored to structure so as to impart expansion towards loops or offsets. Anchors shall be constructed of heavy forged wrought iron, secured to pipe and to structure. Provide vibration isolation as required.
- 3. Provide pipe alignment guides as required to guide expanding pipe to move freely from anchor points toward expansion joints, offsets, etc.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

D. Install refrigerant piping according to ASHRAE 15.

E. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

F. 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.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

I. Install piping to permit valve servicing.

- J. Install piping at indicated slopes at a minimum uniform grade of 0.2 percent upward in direction of flow.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install piping to allow application of insulation.
- N. Select system components with pressure rating equal to or greater than system operating pressure.
- O. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Install drains, consisting of a tee fitting, NPS 3/4 full port ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- R. For hydronic piping, reduce pipe sizes using eccentric reducer fitting installed with level side up.
- S. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- T. Install valves according to Section 230523 "General Duty Valves for HVAC Piping".
- U. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- V. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- W. Install shutoff valve immediately upstream of each dielectric fitting.
- X. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- Y. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
 - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
 - 2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

- Z. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- AA. Install refrigerant piping in protective conduit where installed belowground.
- BB. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- CC. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- DD. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- EE. In conduits, install drain valves at low points and manual air vents at high points.
- FF. Remove standing water in the bottom of trench.
- GG. Do not backfill piping trench until field quality-control testing has been completed and results approved.
- HH. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- II. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- JJ. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

- KK. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230000 "Basic HVAC Requirements.
- LL. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230000 "Basic HVAC Requirements.
- MM. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230000 "Basic HVAC Requirements.
- NN. See Section 230000 "Basic HVAC Requirements" for sleeves and mechanical sleeve seals through exterior building walls.
- OO. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- PP. See Section 264200 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 and larger: Use dielectric flange kits.

3.6 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet.
 2. NPS 1: Maximum span, 7 feet.
 3. NPS 1-1/2: Maximum span, 9 feet.
 4. NPS 2: Maximum span, 10 feet.
 5. NPS 2-1/2: Maximum span, 11 feet.
 6. NPS 3 and Larger: Maximum span, 12 feet.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- H. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.7 PIPE JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction for underground piping.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- J. Mechanically formed, copper tube outlet joints are not allowed.

3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."
- E. Install traps and control valves in accessible locations close to connected equipment.
- F. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- G. Install a drip leg at coil outlet.

3.9 CHEMICAL TREATMENT

- A. Contractor shall provide chemical treatment of new building piping systems per owner requirements. Contractor shall perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics for initial startup.
- B. Contractor shall submit final water analysis of each system to owner and EOR for final acceptance before opening campus utility mains isolation valves to building.
- C. Install bypass chemical feeders in the hydronic system in the penthouse boiler room.
1. Install in upright position with top of funnel not more than 48 inches above the floor.

2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- D. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- E. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.10 WELDING

- A. Weld only by approved acetylene or electric welding processes and welders shall hold certificate from approved insurance company.
- B. Conduct test to demonstrate suitability of procedures to be used in making welds which conform to specified requirements.
- C. Specification for welding procedure shall meet requirements of Welding Qualifications, Section IX, ASME Boiler and Pressure Vessel Code and ANSI B31.1.
- D. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20 percent of thickness. Set flanges and branches properly.
- E. Welder Qualification:
1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not qualify welder for work under another Division or Section.
 2. Tests shall be as prescribed for welder qualification in Section IX of the ASME code.
 3. Records of such tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
 4. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible to the Owner's Project Manager. Before completion of project, one copy of records shall be turned over to Owner.
 5. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re certified.
- F. Welding Tests
1. As designated by Engineer, remove welds for destructive testing or for testing by non-destructive means. Tests shall be as determined by Engineer.

2. If, in Engineer's opinion, welds so tested do not meet requirements of Sections VIII and IX of ASME, remove welds welded by that welder, at no cost to Owner. Rewelding shall be performed by qualified welder other than welder whose welds did not pass test. Welders whose welds were defective shall not be employed on site for remainder of project.
3. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.

3.11 IDENTIFICATION

- A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.12 FIELD QUALITY CONTROL

- A. Prepare piping according to ASME B31.9, "Building Services Piping," and as follows:
 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Coordinate with Owner's Representative for witnessing of tests. Testing of buried piping shall be completed both prior to backfilling and again between 2 to 3 months after backfilling
- E. Perform the following tests on mechanical piping:
 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. The systems shall be proved 100% leak tight for four (4) hour tests (no loss in pressure) under gauge pressures of 1-1/2 times the working pressure specified, but not less than the following:
 - a. Water piping (including pumped steam condensate) 150 PSIG
 - b. Buried piping (all fluids) 250 PSIG
 - c. Low-pressure steam and condensate lines 50 PSIG
 - d. Medium-pressure steam and condensate lines 100 PSIG
 - e. High-pressure-steam, feed and condensate lines 200 PSIG
6. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
7. Prepare written report of testing.

F. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

G. Test conduit as follows:

- a. Seal vents and drains and subject conduit to 15 psig for four hours with no loss of pressure. Repair leaks and retest as required.

H. Adjusting

1. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
2. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
3. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
4. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - a. Open shutoff valves in condenser water circuit.
 - b. Verify that compressor oil level is correct.
 - c. Open compressor suction and discharge valves.

- d. Open refrigerant valves except bypass valves that are used for other purposes.
 - e. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- 5. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.
- I. Prepare test and inspection reports.

3.13 REFRIGERANT SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

END OF SECTION 232000

SECTION 232100 - MECHANICAL PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Special duty valves
 - 2. Safety valves.
 - 3. Pressure-reducing valves.
 - 4. Thermostatic expansion valves.
 - 5. Solenoid valves.
 - 6. Hot-gas bypass valves.
 - 7. Strainers.
 - 8. Thermostatic air vents and vacuum breakers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of mechanical specialty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Hot-Water Heating Piping: 200 psig at 250 deg F.
 2. Makeup-Water Piping: 80 psig 150 deg F.
 3. Condensate-Drain Piping: 100 psig at 150 deg F.
 4. Blowdown-Drain Piping: 100 psig at 200 deg F.
 5. Air-Vent Piping: 800 psig at 150 deg F.
 6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 AIR-CONTROL DEVICES

- A. Manual Air Vents:
 1. Body: Bronze.
 2. Internal Parts: Nonferrous.
 3. Operator: Screwdriver or thumbscrew.
 4. Inlet Connection: NPS 1/2.
 5. Discharge Connection: NPS 1/8.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 225 deg F.
- B. Automatic Air Vents:
 1. Body: Bronze or cast iron.
 2. Internal Parts: Nonferrous.
 3. Operator: Noncorrosive metal float.
 4. Inlet Connection: NPS 1/2.
 5. Discharge Connection: NPS 1/4.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 240 deg F.
- C. Expansion Tanks:
 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. Amtrol.

- b. Armstrong.
 - c. B&G.
 - d. Wheatley.
 - e. Wessels.
2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
 4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
 5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch diameter gage glass, and slotted-metal glass guard.

D. Bladder-Type Expansion Tanks:

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. Amtrol.
 - b. Armstrong.
 - c. B&G.
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Air and Dirt Separators:

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. Spirotherm Spirovent.
 - b. Taco.
 - c. Bell and Gossett.
2. Coalescing type combination air and dirt separator. Welded steel; ASME constructed and labeled for 150 psig pressure and 270 deg F maximum operating temperature.
3. Air collector media shall consist copper core tubes and stainless steel tubes with enhanced surface.

4. Standard velocity units as scheduled.
5. Air elimination efficiency shall be 100%
6. Dirt elimination efficiency shall be 80% removal of particles 30 micron and larger with 100 passes.
7. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
8. Blowdown Connection: Threaded.
 - a. Bottom 1" NPT connection with full port ball valve.
 - b. Side tap 1" NPT connection with full port ball valve for flushing floating debris.
9. Venting: Isolation ball valve on top tank outlet with integral float actuated vent device or high capacity automatic air vent similar to B&G Model 107A.
10. Size: Match system flow capacity.

2.3 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

2.4 MISCELLANEOUS PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

D. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

E. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" Section 15124 "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 PIPING INSTALLATION

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

- C. Install valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."
- D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.3 TERMINAL EQUIPMENT CONNECTIONS

- A. Install traps and control valves in accessible locations close to connected equipment.
- B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

3.4 MECHANICAL SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

- F. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

END OF SECTION 232100

SECTION 232200 - MECHANICAL PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Split-Coupled In-Line Centrifugal Pump

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 SPLIT-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers: Bell and Gossett, Armstrong, Grundfos
- B. Description: Factory-assembled and -tested, centrifugal, split coupled inline installation, in cast iron stainless steel fitted construction.
- C. Pump Construction:
 1. Pump shall be equipped with a unitized inside mechanical seal assembly with flush line. The seal assembly shall have an EPR elastomer bellows and a positive metal to metal drive system to reduce torsional stress on the bellows. The bellows will be pressure supported without creases or folds for long life. The mechanical seal shall have a rotating carbon face against a stationary ceramic face.
 2. Impeller: Stainless steel hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.5-2000. The allowable residual imbalance conforms to ANSI grade 6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.
 3. Pump Shaft: Stainless steel.
 4. The pump shall include a spacer coupling of high tensile aluminum, split to allow the servicing of the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design.
 5. Pump Bearings: Oil lubricated; bronze-journal or thrust type.
- D. Motor: Single speed and rigidly mounted to pump casing.
 1. Premium efficiency for VFD operation, Class F insulation minimum.
 2. 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.
 3. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's installation requirements and as detailed on construction documents.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Install thermometers and pressure gages.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations.
 - 2. Comply with requirements for vibration isolation and control devices specified in Section 230548 "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check valve on discharge side of pumps.
- E. Install Y-type strainer and shutoff valve on suction side of pumps.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- H. Pipe drain to nearest floor drain for overflow and drain piping connections.
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers.
 - 4. Set pump controls for automatic start, stop, and alarm operation.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - d. Verify that pump controls are correct for required application.
 - e. Set throttling valves on pump discharge for specified flow.
 - f. Replace damaged or malfunctioning pump controls and equipment.
 - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.

3.5 DEMONSTRATION

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

END OF SECTION 232200

SECTION 232500 - HVAC WATER TREATMENT AND FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Mechanical contractor to engage owner's contracted water quality vendor to maintain existing water quality standards with newly connected system. Newly installed piping shall be cleaned and flushed as indicated in section 1.4.

1.3 INFORMATIONAL SUBMITTALS

- A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- B. Field quality-control reports.
- C. Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
 - 2. Water Analysis: Illustrate water quality available at Project site.

1.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Acidity and Alkalinity: ASTM D 1067.
 3. Iron: ASTM D 1068.
 4. Water Hardness: ASTM D 1126.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including hot-water heating shall have the following water qualities:
1. pH: Maintain a value within 9.0 to 10.5.
 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 3. Boron: Maintain a value within 100 to 200 ppm.
 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 6. TSS: Maintain a maximum value of 10 ppm.
 7. Ammonia: Maintain a maximum value of 20 ppm.
 8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.

- d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
- e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 - 1. Capacity: 2 gal.
 - 2. Minimum Working Pressure: 125 psig.

2.3 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 2. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 3. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

4. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 5. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 6. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At eight week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Steam System: ASTM D 1066.
 3. Acidity and Alkalinity: ASTM D 1067.
 4. Iron: ASTM D 1068.
 5. Water Hardness: ASTM D 1126.

END OF SECTION 232500

SECTION 233113 - MECHANICAL DUCTS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Backdraft and pressure relief dampers.
7. Manual volume dampers.
8. Fire dampers.
9. Flange connectors.
10. Remote damper operators.
11. Duct-mounted access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

- B. Related Sections:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
2. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
4. Section 283112 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each type of product indicated and which system(s) the products are to be applied including sizes, capacities, pressure drops (not to exceed scheduled models).

A. 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, liner material, 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.
13. Sheet metal thickness(es).
14. Access doors including frames, hinges, and latches.
15. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
16. Special fittings.
17. Manual volume damper installations.
18. Control-damper installations.
19. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
20. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

- B. Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

- C. 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 and soffits.
- D. Welding certificates.
- E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- B. All product warranties which shall cover materials and labor for a minimum of 1 year (or longer as specified herein for some products) from the date of acceptance.
- C. All documentation required for project completion, including contractor's project completion certificate in accordance with MA code 780CMR 107.6.3 indicating that the installation is in accordance with the approved construction documents and all applicable local, state and federal statutes and regulations. All pertinent deviations shall be specifically noted in the certificate.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- D. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

A. Mockups:

1. Before installing duct systems, build mockups representing above ceiling coordination conditions for two bedrooms. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
 - a. Transverse joints.
 - b. Fire rated access door(s).
 - c. Fresh air branch connections
 - d. Supply and return duct work typical flexible duct or flexible-connector connections for each duct and apparatus.
 - e. 90-degree turn(s) with turning vanes.
 - f. Fire damper(s).
 - g. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be protected during delivery, storage on site, and use from water or other damaging conditions. Any damaged materials shall be replaced with new.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate sizes and locations of steel supports. Supports are specified in Section 055000 "Metal Fabrications."

PART 2 - PRODUCTS

2.1 SINGLE-WALL 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 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- 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 4, "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 SINGLE-WALL 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.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 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 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) 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 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

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: G90.
 - 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. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. 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.
- G. 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 DUCT ACCESSORY ASSEMBLY DESCRIPTION

- 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 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.

2.5 DUCT ACCESSORY MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- 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.

2.6 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity balanced.
- B. Maximum Air Velocity: 2000 fpm.
- C. Maximum System Pressure: 2-inch wg.
- D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners or mechanically attached mounting flange.
- E. Blades: Multiple single-piece blades, off-center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: Extruded vinyl, mechanically locked.
- H. Blade Axles:
 - 1. Material: Plated steel or Stainless steel
 - 2. Minimum Diameter: 0.20 inch
- I. Tie Bars and Brackets: Galvanized steel.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic pivot bushings.
- L. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.

2.7 COUNTER BALANCED BACKDRAFT DAMPERS

- A. Manufacturers: Ruskin, Greenheck, Nailor, or approved equal.
- B. Dampers shall be multi-blade, weighted type with counter-balanced blades assembly and with 12 ga galvanized steel frame and extruded aluminum airfoil-shaped blades equal to Ruskin Type CBS92. Counter balance assembly shall be adjustable for field adjustment. Blade edges shall have silicon rubber seals with ball bearings. Dampers shall be suitable for flange and gasket connection to ductwork or fan outlet.

- C. Dampers shall be rated to maximum velocity of 4000 fpm, maximum temperature of 250°F and maximum system pressure of 5" WG for damper width of 60" and 14" WG for damper width of 12".
- D. Maximum damper leakage shall be 13.5 cfm/sf based on pressure differential of 1" WG.

2.8 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

- 1. Standard leakage rating, with linkage outside airstream.
- 2. Suitable for horizontal or vertical applications.
- 3. Frames:
 - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 4. 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.
- 5. Blade Axles: Galvanized steel.
- 6. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

- 1. Standard leakage rating, with linkage outside airstream.
- 2. Suitable for horizontal or vertical applications.
- 3. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
- 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
- 5. Blade Axles: Stainless steel.

6. Bearings:

- a. Stainless-steel sleeve.
- b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Aluminum.

C. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.9 FIRE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream, except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 1. Minimum Thickness: 0.138 inch or 0.39 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.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.024-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.10 SMOKE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted or mechanically attached corners and mounting flange.
- E. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
- F. Smoke Detector: Integral, factory wired for single-point connection.
- G. Blades: Roll-formed, horizontal, overlapping, galvanized sheet steel.
- H. Leakage: Class I.
- I. Rated pressure and velocity to exceed design airflow conditions.
- J. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
- K. Damper Motors: two-position action.
- L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

M. Accessories:

1. Auxiliary switches for signaling position indication.
2. Test and reset switches.

2.11 FLANGE CONNECTORS

- A. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- B. Material: Galvanized steel.
- C. Gage and Shape: Match connecting ductwork.

2.12 REMOTE DAMPER OPERATORS

- A. Description: Cable system designed for remote manual damper adjustment.
- B. Tubing: Aluminum.
- C. Cable: Stainless steel
- D. Wall-Box Mounting: Recessed.
- E. Wall-Box Cover-Plate Material: Stainless steel.

2.13 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. 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: Continuous and two compression latches.
- d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.14 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 175 deg F.
 - 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

2.15 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two 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.
- D. 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.

2.16 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.

2.17 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. 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.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) 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.

2.18 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 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. 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.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports for Metal Ducts:
 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 Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 DUCT ACCESSORY 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 control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. 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.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.

- G. Install fire and smoke dampers according to UL listing.
- H. Connect ducts to duct silencers.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes, relief plenums, and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. 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.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream and downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
 - 1. Inspection and Hand Access: 12 by 6 inches.
 - 2. Head and Hand Access: 18 by 10 inches.
 - 3. Head and Shoulders Access: 21 by 14 inches.
 - 4. Body Access: 25 by 14 inches.
 - 5. Body plus Ladder Access: 25 by 17 inches.
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal units to supply ducts directly, no flexible duct allowed.
- P. Connect diffusers or light troffer boots to ducts directly or with maximum 72-inch lengths of flexible duct clamped or strapped in place. Refer to installation details on mechanical drawings.
- Q. Connect flexible ducts to metal ducts with stainless steel draw bands.
- R. Install duct test holes where required for testing and balancing purposes.

- S. 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.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "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.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "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.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Pressure test all ducts after takeoffs and wall penetrations are in place and before applying exterior insulation. Correct any leaks.
2. Leak test 100 percent of the surface area of all outdoor air, paint booth exhaust, and welded ducts (note that welded duct shall be test using an equivalent Leakage Class 1) and 100 percent of the surface area for ducts listed as Pressure Class 4 and higher construction at a test pressure of 110 percent +/- 5 percent of the rated duct Pressure Class (example: 4 inch duct construction would be tested at between 4.2 and 4.6 inches of static pressure). Duct shall be constructed so there is no joint or structural failure at the test pressure.
3. Leak testing shall be per SMACNA HVAC Air Duct Leakage Test Manual. Provide orifice assembly including straightening vanes, orifice plate mounted in straight tube with properly located pressure taps, and U tube manometer or other device as specified by SMACNA. Orifice assembly shall be calibrated accurately and shall come with calibration curve. Leakage classes shall be as previously specified. Submit leak test report (per SMACNA format) for Engineer review. Drawings of ductwork tested shall also be submitted with report, indicating presence of takeoffs, wall penetrations, joints, etc.
4. Test the following systems:
 - a. Supply Air Distribution Ducts with a Pressure Class of 2-Inch wg or Higher: Test 100 percent of total installed duct mains for each designated pressure class.
 - b. Medium Pressure Air Distribution with a Pressure Class of 4-inch wg or Higher: Test 100 percent of total installed duct mains for each designated pressure class
5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
6. Test for leaks before applying external insulation.
7. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
8. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
9. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

- D. Duct systems and accessories will be considered defective if it does not pass tests and inspections.
- E. Operate dampers to verify full range of movement.
- F. Inspect locations of access doors and verify that purpose of access door can be performed.
- G. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
- H. Inspect turning vanes for proper and secure installation.
- I. Operate remote damper operators to verify full range of movement of operator and damper.
- J. Prepare test and inspection reports.

3.9 DUCT CLEANING

- A. Clean all new supply, return, and exhaust diffusers, grilles, registers, dampers and ductwork shall be cleaned internally and externally.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Supply Ducts, including conditioned outdoor air:

1. Material: Galvanized.
2. Ducts Connected to VAV boxes:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 12.
3. Ducts Connected to RTU 1&2, AHU-1(new duct):
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round: 6.

4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round: 6.
- B. Return Ducts:
 1. Material: Galvanized.
 2. Ducts Connected to RTU-1 & 2
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 12.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round: 6.
- C. Exhaust Ducts:
 1. Material: Aluminum.
 2. Any new ductwork.
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12
 - d. SMACNA Leakage Class for Round: 12.
- D. Intermediate Reinforcement:
 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
- E. Elbow Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "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 4-3, "Vanes and Vane Runners," and Figure 4-4, "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 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "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.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

- 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 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "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 233413 - HVAC FANS AND VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Ceiling Mounted Ventilator

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, furnished specialties, and accessories for each fan.
 - 2. Certified fan performance curves with system operating conditions indicated.
 - 3. Certified fan sound-power ratings.
 - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 5. Material thickness and finishes, including color charts.
 - 6. Dampers, including housings, linkages, and operators.
 - 7. Fan speed controllers.
 - 8. Roof curbs.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For axial fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: Two set(s) for each belt-driven unit.

1.7 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
 2. Operating Limits: Classify according to AMCA 99.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 EXHAUST FANS

- A. Description: Refer to Exhaust Fan Schedule on Drawings.
1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- B. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 3. Horizontally split, bolted-flange housing.
 4. Spun inlet cone with flange.
 5. Outlet flange.
- C. Airfoil Wheels:
1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
 2. Heavy backplate.
 3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- D. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Prelubricated and Sealed Shaft Bearings:
1. Self-aligning, pillow-block-type bearings.
 2. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
 3. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

F. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, L10 at L10 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 at L10 at 120,000 hours.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, L10 at L10 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 at L10 at 120,000 hours.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Spark-Resistant Construction: AMCA 99.
8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230000 "Basic Mechanical Requirements."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans in accordance with manufacturer's Installation, Operation, and Maintenance manual. Fans shall be level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

- D. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- E. Install units with clearances for service and maintenance.
- F. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233100 "HVAC Ducts."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

END OF SECTION 233413

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-duct air terminal units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Liners and adhesives.
 - 3. Sealants and gaskets.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

1.7 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

2.2 SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Diverting-damper assembly inside unit casing with control components inside a protective metal shroud.
- B. Casing: 22 gage zinc coated steel wall.
 - 1. Casing Lining: Adhesive attached, 1/2-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 - 2. Air Inlet: Round stub connection for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- C. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- D. Controls: Refer to Section 230920 "Direct Digital Control (DDC) System"

2.3 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. Steel Cables: Stainless steel complying with ASTM A 492.
- D. 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.
- E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
 - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "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 and for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. 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.

3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Section 233113 "Mechanical Ducts and Accessories."
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233113 "Mechanical Ducts and Accessories."

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

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

D. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
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.

E. Air terminal unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Perforated diffusers.
 - 3. Linear slot diffusers.
 - 4. Modular core supply grilles.
 - 5. Adjustable bar registers and grilles.
 - 6. Fixed face registers and grilles.
 - 7. Linear bar grilles.

1.3 ACTION 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 Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Price.
2. Titus.
3. Nailor.
4. Metalaire.

2.2 CEILING DIFFUSERS

- A. Square Ceiling Diffusers:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel for non-humid environments. Aluminum for restrooms.
3. Finish: Baked enamel, white.
4. Face Size: 24" x 24".
5. Face Style: Plaque.
6. Mounting: As scheduled.
7. Pattern: Adjustable.
8. Accessories:
 - a. Equalizing grid.
 - b. Sectorizing baffles.

- B. Perforated Ceiling Supply Diffuser, Face Deflector

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel for non-humid environments. Aluminum for restrooms.
3. Finish: Baked enamel, white.
4. Face Size: 24" x 24".
5. Face Style: Perforated, no less than 51% free area
6. Mounting: As scheduled.
7. Pattern: Air deflector modules shall allow full adjustment of air flow patter from one-way to four-way discharge without affecting the free area or the pressure and noise performance of the diffuser
8. Accessories:
 - a. Air deflector modules located on back of perforated face of diffuser.

2.3 REGISTERS AND GRILLES

- A. Adjustable Bar Grilles and Registers

1. Material: Steel for non-humid environments. Aluminum for restrooms.

2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Horizontal spaced 1-1/2 inches apart.
4. Core Construction: Removable.
5. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
6. Frame: 1 inch wide.
7. Mounting: As scheduled.
8. Damper Type: As scheduled.

B. Fixed Face Grilles and Registers:

1. Material: Steel for non-humid environments. Aluminum for restrooms.
2. Finish: Baked enamel, white.
3. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
4. Core Construction: Removable.
5. Frame: 1 inch wide.
6. Mounting: As scheduled.
7. Damper Type: As scheduled.

2.4 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 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 ADJUSTING

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

END OF SECTION 233713

ROOF-TOP UNIT DX PACKAGED EQUIPMENT WAS PRE-PURCHASED BY OWNER. THIS SPECIFICATION PROVIDED FOR INFORMATIONAL PURPOSES ONLY.

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged air-handling units (rooftop units) with the following components and accessories:
 - 1. Gas Furnace
 - 2. Economizer outdoor- and return-air damper section.
 - 3. Integral, space temperature controls.
 - 4. Roof curb adaptors.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Curb adaptors.
- C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set of filters for each unit.

1.7 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 203/110 and ARI 303/110 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 refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than five years from date of Substantial Completion.

1.9 FINAL CLEANING

- A. Outside and inside of each air handling unit shall be thoroughly cleaned. Use industrial grade cleaners to remove construction dust, sheet metal mill finish or grease. All proposed cleaning materials shall have contents identified and approved prior to use. Cover unit openings with sheet metal or other proper material until ductwork is connected to maintain unit cleanliness.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design; Daikin (Owner Preferred)
- B. Approved for Alternate Bid: Contractor may provide an alternate price for manufacturers listed below:
 - 1. Trane

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 1. Exterior Casing Thickness: 18 gauge galvanized steel, phosphatized, and finished with baked enamel finish. Coating shall be corrosion resistant exceeding ASTM B117 salt spray testing of 672 hours.
 - 2. Service doors shall be provided on the fan section, filter section, control panel section, coil sections, and heating vestibules in order to provide user access to unit components. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system.
 - 3. Interior Liner: 18 gauge galvanized steel. Coating shall be corrosion resistant exceeding ASTM B117 salt spray testing of 672 hours.
- C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Thickness: 2" injected foam, R13
 - 3. 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.
 - 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- D. Condensate Drain Pans: Formed sections of galvanized or stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple.
 - 3. Pan-Top Surface Coating: Corrosion-resistant compound.
 - 4. Provide condensate drain pan overflow switch to shut unit down in event condensate drain is clogged.
- E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

- A. Direct-Driven Supply-Air Fans: Vane axial with permanently lubricated, ECM motor resiliently mounted in the fan inlet. 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. Powered Exhaust Fan: Exhaust fan shall be single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be direct drive fan mounted to the motor shaft. The unit DDC Controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed to airflow to maintain the adjustable building pressure setpoint.

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coils from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating or Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Hot Gas Reheat Coil:

1. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.
2. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity.
3. Each coil shall be factory leak tested with high pressure air under water.

C. Gas Furnace:

1. Factory assembled, piped, and wired, complying with ANSI Z21.47 and NFPA 54.
 - a. CSA Approval: Designed and certified by and bearing label of CSA.
2. Burners: Stainless Steel
 - a. Fuel: Natural Gas
 - b. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
3. Heat-Exchanger and Drain Pan: Stainless Steel
4. Venting: Gravity Vented
5. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
6. Safety Controls:
 - a. Gas Control Valve: Modulating
 - b. Gas Train: Single-body, regulated, redundant, 24V AC gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: See Mechanical Schedules

- B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- C. Refrigeration Specialties:
 - 1. Refrigerant: R-32 or R-454B
 - 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. Minimum: 2" Merv 8 & 4" Merv 13 (minimum) .
- B. Filters shall be integrally mounted within unit and be accessible through hinged access doors.
- C. Filters shall be as specified and scheduled. Holding frames shall be factory installed and prevent bypass air.
- D. Furnish each unit with 3 sets of filters. One (1) set will be used for construction startup. Replace construction filters at project closeout. Final set is owner stock.

2.7 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with 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: Motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

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

2.9 CONTROLS

- A. Control equipment and sequence of operation are specified in the drawings on Sheet M6.00.
- B. Basic Unit Controls:
 - 1. Wall-mounted thermostat or sensor with the following features:
 - a. Temperature setpoint control
 - b. Occupancy Override
 - c. Communication module
 - d. Hot/cold thumbwheel
 - 2. Housing Material: Polycarbonate/ABS, UV protection. Mounting should fit a standard 2"by 4" junction box.
- C. Control Wiring: Factory wire connection for controls' power supply.
- D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- E. Unit-Mounted Status Panel:
 - 1. Minimum 7" touchscreen.
 - 2. Cooling/Off/Heating Controls: Control operational mode.
 - 3. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
 - 4. Status Lights:
 - a. Filter dirty.
 - b. Fan operating.
 - c. Cooling operating.
 - d. Heating operating.
 - e. General alarm.
 - 5. Digital Numeric Display:
 - a. Outdoor airflow.
 - b. Supply airflow.
 - c. Outdoor dry-bulb temperature.
 - d. Outdoor dew point temperature.
 - e. Supply temperature.
 - f. Supply relative humidity.
 - g. Space relative humidity.
- F. Control Dampers:
 - 1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.

2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
4. Damper Label: Bear the AMCA seal for both air leakage and performance.
5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
6. Damper Frame Material: Stainless steel.
7. Blade Type: Hollow-shaped airfoil.
8. Blade Material: Stainless steel.
9. Maximum Blade Width: 6 inches.
10. Maximum Blade Length: 48 inches.
11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
12. Bearings: Thrust bearings for vertical blade axles.
13. Airflow Measurement:
 - a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
 - b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
 - c. Accuracy of flow measurement: Within 5 percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
 - d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
 - e. Flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.

G. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
3. Maximum Operating Time: Open or close damper 90 degrees in 90 seconds.
4. Adjustable Stops: For both maximum and minimum positions.
5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
6. Spring-return operator to fail-safe; either closed or open as required by application.
7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
8. Position feedback Signal: For remote monitoring of damper position.
9. Coupling: V-bolt and V-shaped, toothed cradle.
10. Circuitry: Electronic overload or digital rotation-sensing circuitry.

H. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 50 percent.

I. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
 - a. Discharge-air temperature.
 - b. Discharge-air relative humidity.
 - c. Refrigeration system operating.
 - d. Constant and variable motor loads.
 - e. EC motor operation.
 - f. Cooling load.
 - g. Air-distribution static pressure and ventilation-air volumes.

J. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

1. Hardwired Points:
 - a. Monitoring: On-off status, common trouble alarm.
 - b. Control: On-off operation, space temperature set-point adjustment.
2. ASHRAE 135 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

2.10 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open. Circuit shall be field wired by others.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

- D. Coil guards of painted, galvanized-steel wire.
- E. Louvered Hail guards of galvanized steel, painted to match casing.
- F. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment rigging and installation:
 - 1. Comply with manufacturers rigging and installation instructions for unloading units and moving to final locations.

3.3 CONNECTIONS

- A. Coordinate piping and duct installations and specialty arrangements with schematics on Drawings and with requirements specified in piping and duct systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Verify condensate drainage requirements of authorities having jurisdiction.
- C. Install condensate drain, minimum connection size, with trap and indirect connection to roof deck.
- D. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
- E. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

3.4 FIELD QUALITY CONTROL

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

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

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean condenser coil and inspect for construction debris.
 - 10. Remove packing from vibration isolators.
 - 11. Inspect operation of barometric relief dampers.
 - 12. Verify lubrication on fan and motor bearings.
 - 13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 14. Adjust fan belts to proper alignment and tension.
 - 15. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 - 16. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 17. Operate unit for an initial period as recommended or required by manufacturer.
 - 18. Calibrate thermostats.
 - 19. Adjust and inspect high-temperature limits.

20. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
21. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
22. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
23. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
24. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
25. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.
26. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 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.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 237413

SECTION 260100 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 26

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 - 1. Submittals.
 - 2. Coordination drawings.
 - 3. Record documents.
 - 4. Maintenance manuals.
 - 5. Rough-ins.
 - 6. Electrical installations.

1.3 SCOPE OF WORK

- A. The work under this section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, tested, and ready for operation.
- B. Construction Schedule:
 - 2. The project will be phased as outlined below. Project completion for turnover to Owner is to be December 12, 2025.
- C. Phasing: The project shall be phased construction as indicated on the drawings. Refer to drawings for specific requirements. General phasing requirements shall be as follows:
 - 3. Phase 1: Level 3 and Level 4 (Roof/Penthouse)
 - a. Contractor shall maintain operations on Levels 1 and 2 for business continuity. Disruptions of service will be coordinated with owner at beginning of phase.
 - 4. Phase 2: Level 2
 - a. Contractor shall maintain operations on Levels 1 and 3 for business continuity. Disruptions of service will be coordinated with owner at beginning of phase.

3. Board Room Schedule

- a. The Board Room on Level 2 shall be maintained accessible and operational for Board meetings on the following dates. Contractor shall identify dates in construction schedule and coordinate with Owner for construction during meeting times.

- 1) May 15, 2025
- 2) June 12, 2025
- 3) July 17, 2025
- 4) August 21, 2025
- 5) September 18, 2025
- 6) October 16, 2025
- 7) November 20, 2025
- 8) December 18, 2025

- D. Contractor shall use existing stairwell for access to work areas. Building will remain occupied during construction and contractor shall minimize disruption to occupied areas. Refer to general conditions for building requirements.

1.3 GLOSSARY

ACI	American Concrete Institute
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AFBMA	Anti-Friction Bearing Manufacturers' Association
AMCA	Air Moving and Conditioning Association, Inc.
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
FM	Factory Mutual Insurance Company
IBR	Institute of Boiler & Radiation Manufacturers
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Institute
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
SBI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UFPO	Underground Facilities Protective Organization

UL Underwriters' Laboratories, Inc.
OSHA Occupational Safety and Health Administration
UFPBC Building Code

Approval/Approved	Materials, Equipment, or Methods deemed to be acceptable solely by the Engineer and documented in writing.
As Called For	Contractor shall provide materials, equipment and their execution specified/shown in the Contract Documents.
Code Requirements	Minimum requirements.
Concealed	Install work in pipe/duct shafts, building chases or recesses, inside of hollow wall construction, above ceilings, within floor slabs, or below grade.
Contractor	Person or persons responsible for the execution of this Contract, as governed by these construction documents.
Exposed	Work not identified as concealed.
Equal or Equivalent	Materials, Equipment, or Methods determined to be acceptable substitutions for specified design criteria.
Final Acceptance	Final project review where a previously established "punch list" will be used as the basis for determining project completeness and award of final payment.
Furnish	Supply and deliver to installed location.
Furnished By Others, Installed by Contractor	Receive delivery at jobsite, or where called for, and install.
Inspection	Visual observations by Owner's Site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Third party agencies amongst those accredited by the North Carolina Building Code Council to Label Electrical & Mechanical Equipment.
May	Allows contractor a choice.
Or Approved Equal	Materials, Equipment, or Methods determined to be acceptable substitutions for specified design criteria, solely by the Engineer and documented in writing.
Prime Professional	Architect or Engineer having a Contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport existing equipment to new location, then clean, test and install ready for use.
Replace	Remove existing equipment and/or item and provide new.

Review	A general contractual conformance check of specified products.
Roughing	Preliminary layout and installation of pipe, duct, conduit, equipment.
Satisfactory	As specified in Contract Documents.
Shall	Indicates a mandatory requirement.

1.4 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS."
- B. Provide electronic files of electrical related shop drawings and product data submitted.
- C. Additional copies may be required by individual sections of these Specifications.
- D. Submittal Document Quality: Submittals containing poor quality copies will be automatically Rejected and returned to Contractor without review.

1.5 COORDINATION DRAWINGS

- B. Coordination Drawings: The coordination model will be reconciled by each Contractor to find the best collective solution to the coordination of all items.
 - 1. Each Contractor will supply a coordination drawings for their own scope of work separated by areas as directed by General Contractor.
 - 2. Each Contractor will be responsible for working in harmony with the other Contractors to resolve coordination issues.
 - 3. Contractor drawings will be color coded to provide delineation between systems as directed by the General Contractor.
 - 4. Coordination drawings will still be required as directed by General Contractor and for shop drawing approvals.
- C. Time is of the essence on this project. Contractor is responsible for all efforts, methods, procedures and costs required to meet or better the scheduled dates. If, at any time, it is determined by the General Contractor or the Owner's Project Manager that this Contractor is not on schedule for any reason within the control or responsibility of the Contractor, the Contractor shall increase its manpower or work such overtime as is required to bring the work back within the Project Schedule. Such additional efforts shall be performed at no additional cost to the General Contractor or the Owner.
- D. The proposed schedule includes "estimated" start dates for the construction activities. In the interest of the Project, the General Contractor reserves the right to alter the sequencing of activities in order to accommodate the project conditions or Authority requirements. It is understood that the Contractor shall be obligated to complete its activities within the specified durations regardless of the actual start date. Contractor agrees to meet or better each duration. The Contractor shall advise the Owner's project manager of any and all automated scheduling software being used on the project.

1.6 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1 Section 01 77 00 "CLOSEOUT PROCEDURES." In addition to the requirements specified in Division 1, indicate installed conditions for:
1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.7 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 Section 01 77 00 "CLOSEOUT PROCEDURES." In addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
 5. Include copies of test reports, fire alarm battery calculations, and fire alarm voltage drop calculations in the fire alarm system maintenance manuals.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.9 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. It is the intention of the specifications and drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the drawings, but mentioned in the specifications or vice-versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by this Contractor without additional expense to the Owner.

- B. The drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the project and shall have the approval of the Owner's Representative before being installed. This Contractor shall follow drawings, including his shop drawings, in laying out work and shall check the drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Owner's Representative before proceeding with the installation. This Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- C. The drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the project and shall have the approval of the Owner's Representative before being installed. This Contractor shall follow drawings, including his shop drawings, in laying out work and shall check the drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Owner's Representative before proceeding with the installation. This Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- D. Any requests for information (RFI) for resolving an apparent conflict or unclarity, or a request for additional detail, shall include a sketch or equivalent description of Contractor's proposed solution.
- E. Size of conduits, cable trays, raceways and methods of running them are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge. All work shall be installed in an approved workmanlike manner.

1.10 INSPECTION OF SITE CONDITIONS

- A. Prior to submission of bid, visit the site and review the related construction documents to determine the conditions under which the Work has to be performed and send a report, in writing, to the Owner's Representative, noting any conditions which might adversely affect the Work of this section of the specifications.

1.11 SURVEY AND MEASUREMENTS

- A. Base all required measurements, horizontal and vertical, from referenced points established WITH the Owner's Representative. The Electrical Contractor shall be responsible for correctly laying out the Work required under this section of the specifications.
- B. In the event of discrepancy between actual measurements and those indicated, notify the Owner's Representative in writing and do not proceed with the related work until instructions have been issued.

1.12 PROTECTION OF WORK AND PROPERTY

- A. This Contractor shall be responsible for the care and protection of all work included under this section until the completion and final acceptance of this Contract.
- B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.
- C. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.13 SUPERVISION

- A. Supply the service of a competent Supervisor with a minimum of five (5) years of experience in Electrical construction supervision who shall be in charge of the Electrical work at the site.

1.14 SAFETY PRECAUTIONS

- A. Life safety and accident prevention shall be a primary consideration. Comply with all of the safety requirements of the Owner and OSHA throughout the entire construction period of the project.
- B. Furnish, place and maintain proper guards and any other necessary construction required to secure safety of life and/or property.

1.15 SCHEDULE

- A. Construct work in sequence under provisions of Division 1 and as coordinated with the Owner's Representative.

1.16 ACCESSIBILITY

- A. All work provided under this section of the specification shall be installed so that parts requiring periodic inspection, maintenance and repair are accessible. Work of this trade shall not infringe upon clearances required by equipment of other trades, especially code required clearances to electrical gear. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the Owner's Representative.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 33 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 4. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 5. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 - 6. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
 - 7. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 - 8. Install access panel or doors where units are concealed behind finished surfaces. Coordinate access panel's location with architect. Access panels and doors are specified in Division 26 Section "BASIC ELECTRICAL MATERIALS AND METHODS."
 - 9. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Install equipment and materials in existing structures.
 - e. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 INSPECTIONS

- A. It is the responsibility of the Electrical contractor to notify the Office of the State Electrical Inspector at the State Construction Office to schedule required inspections including rough-in, above ceiling and final inspections.

END OF SECTION 260100

SECTION 260125 - DIVISION OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Division 1 - Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to Division 26 specifications. There shall be no exceptions.
- B. Refer to Section 260100, Basic Electrical Requirements

1.2 DESCRIPTION OF WORK

- A. This section delineates the division of work between Division 23 and Division 26.
- B. Specific work (necessary for the operation of Division 23 equipment), to be done under Division 26, is listed/described below. All other work necessary for the operation of Division 23 equipment shall be performed under Division 23.
- C. All individual motor starters (for mechanical equipment – e.g. fans, pumps, etc.) shall be furnished and installed under Division 23, unless indicated as part of a motor control center (MCC). Motor starters and controls in MCC's, for mechanical equipment, shall be furnished and installed under Division 26.
- D. Division 26 shall provide power wiring and raceway (feeder/branch circuitry), and line side terminations, up to a termination point consisting of a junction box, trough, starter, disconnect switch, MCC, or variable speed/frequency drive (VSD/VFD). Division 23 shall provide (feeder/branch circuitry) from the termination point to the mechanical equipment (or VSD/VFD, if applicable), including final connections.
- E. Division 23 shall provide VSD/VFD's (if applicable).
- F. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 23.
- G. Electrical control wiring and diagrams for connection (to temperature controllers, push buttons, interlocks in motor controllers, pneumatic switches, etc.) shall be shown/specified in Division 23.
- H. Division 23 shall furnish all equipment with complete internal control wiring.
- I. All electrical work specified in Division 23 shall conform to provisions of Division 26. All control wiring shall be in conduit in compliance with Division 26.
- J. Division 23 shall provide motor disconnect switches, outlets, and/or junction boxes for pumps and air compressors. Division 23 shall provide motor sentinel switches for exhaust fans, unit heaters, and ventilators.

- K. All relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other items associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.
- L. All wiring required for controls and instrumentation, not indicated on Division 26 drawings, shall be furnished and installed by Division 23.
- M. Roof exhaust fans, with built-in disconnects provided under Division 23, shall be wired under Division 26 to the line side of the disconnect switch. If any fan is not provided with a built-in disconnect switch, one shall be provided under Division 26.
- N. The sequence of control for all equipment shall be as indicated on the Division 23 Drawings and specifications.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 260125

SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Electrical identification.
 - 3. Electricity-metering components.
 - 4. Concrete equipment bases.
 - 5. Electrical demolition.
 - 6. Cutting and patching for electrical construction.
 - 7. Touchup painting.

1.3 SUBMITTALS

- A. Product Data: For electricity-metering equipment.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label Electrical & Mechanical Equipment for intended location and application.
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon-steel wedge or sleeve type.

- H. Toggle Bolts: All-steel springhead type.
- I. Powder-Driven Threaded Studs are not allowed.

2.2 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.3 SLEEVE SEALS

- A. Retain this Article if annular space between pipe sleeves and cables must be sealed against hydrostatic pressure. Sleeve seals are usually furnished with EPDM sealing elements, plastic pressure plates, and carbon-steel bolts. NBR and silicone sealing elements, carbon- and stainless-steel pressure plates, and stainless-steel bolts are available for special applications.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
- C. 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: Carbon steel or Stainless steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 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.

2.5 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch-diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts and machine screws, or standard pre-set inserts.
 - 5. Steel: Welded threaded studs or spring-tension clamps on steel.
 - 6. Field Welding: Comply with AWS D1.1. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 7. Light Steel: Sheet-metal screws.
 - 8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section 07 84 13 "Penetration Firestopping."

3.5 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety. The owner shall be provided first right of refusal for all demolished electrical equipment.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove demolished material from Project site. The owner shall be provided first right of refusal for all demolished electrical equipment. All items refused by the owner shall be removed from the project site by the contractor.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- F. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.6 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.7 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Supporting devices for electrical components.

2. Electrical identification.
3. Electricity-metering components.
4. Concrete bases.
5. Electrical demolition.
6. Cutting and patching for electrical construction.
7. Touchup painting.

3.8 REFINISHING AND TOUCHUP PAINTING

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

3.9 CLEANING AND PROTECTION

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

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7 and shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment
- B. Comply with NFPA 70, Comply with NEMA and IPCEA standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.6 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wires and Cables:
 - a. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - b. BICC Brand-Rex Company.
 - c. Carol Cable Co., Inc.
 - d. Senator Wire & Cable Company.
 - e. Southwire Company.
 - 2. Connectors for Wires and Cables:
 - a. AMP Incorporated.
 - b. General Signal; O-Z/Gedney Unit.
 - c. Monogram Co.; AFC.
 - d. Square D Co.; Anderson.
 - e. 3M Company; Electrical Products Division.

2.2 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications" Article.
- B. Rubber Insulation Material: Comply with NEMA WC 3.
- C. Thermoplastic Insulation Material: Comply with NEMA WC 5.
- D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- F. Conductor Material: Copper, soft, drawn, 98% conductivity.
- G. Stranding: Solid conductor for No. 10 AWG and smaller; class B stranded conductor for larger than No. 10 AWG.

2.3 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes receiving wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRE AND INSULATION APPLICATIONS

- A. Service Entrance: Type RHW or THWN, in raceway.
- B. Feeders: Type THHN/THWN, in raceway.
- C. Branch Circuits: Type THHN/THWN, in raceway.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- B. Branch Circuits:
 - 1. Minimum branch circuit conductor size No.12 AWG.
 - 2. New circuits shall consist of a dedicated phase conductor and a dedicated neutral conductor with a grounding conductor; it shall be permitted to share the grounding conductor. A maximum of three (3) phase conductors and three (3) dedicated neutral conductors with a shared grounding conductor shall be permitted in a single raceway (3/4" min.).
 - 3. Receptacle branch circuits: Each 120V, 20 ampere single pole receptacle circuit shall originate at the panelboard with a dedicated phase, neutral and ground conductor. 120V receptacle circuits are #12 AWG minimum, Multi-circuit homeruns shall not be permitted. Shared neutral conductors shall not be permitted.
 - 4. Existing receptacles that currently share a common neutral may remain as installed providing no modifications of the existing circuit are made where the circuits originate at the panelboard.
 - 5. Where phase conductors are increased in size due to any design factor, the neutral conductor shall be increased proportionally (per cross-sectional area – in circular mils) to meet NEC requirements. The ground conductor shall be increased to the corresponding correct size per NEC Article 250.122.
- C. Branch circuit wire sizes shall be increased to avoid excessive voltage drop as follows:
 - 1. Nominal 120 Volt Circuits: Increase one wire size for each 75 feet or portion thereof in excess of 50 feet between the panelboard and the first outlet.

- D. Conductors connected to the emergency system(s) shall not be installed in the same conduits and/or junction or outlet boxes as conductors connected to other systems.
- E. Remove existing wires from raceway before pulling in new wires and cables.
- F. Pull Conductors: 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.
- G. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- H. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- I. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- J. Seal around cables penetrating fire-rated elements according to Division 7 Section 07 84 13 "Penetration Firestopping."
- K. Identify wires and cables according to Division 26 Section "Basic Electrical Materials and Methods."

3.4 CONNECTIONS

- A. Conductor Splices: Keep to minimum.
 - 1. Splices and Taps shall be strictly prohibited within Fire Alarm Circuits other than those clearly specified elsewhere.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- 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.

3.5 TESTING

- A. General: Test all wire and cable for continuity and short circuits prior to energizing. Correct all faulted circuits when detected.

- B. Test shall be in accordance with NETA ATS-2003 Section 7.3.2. Minimum insulation resistance shall not be less than 100 megohms.
- C. Feeder Resistance Testing:
 - 1. All current carrying phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500-volt insulation resistance tester. The procedures listed below shall be followed:
 - a. This includes not only new conductors, but all existing re-used or reworked feeders. Contractor shall test these cables to validate their condition prior to use.
 - 2. After all fixtures, devices, and equipment are installed and all connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and take a insulation resistance tester reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel until source of the low reading is found. The contractor shall correct troubles, reconnect, and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
 - 3. At final inspection, the contractor shall furnish a insulation resistance tester and show the engineers and State Construction Office representatives that the panels comply with the above requirements. He shall also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.
- D. The testing shall be performed by experienced qualified personnel.
- E. Notify the Designer at least one week in advance of test date(s).
- F. Provide a written test report to the designer within 24 hours after completion of each test. Testing information shall include; time of day, date, temperature and all pertinent test information.
- G. Submit all testing reports to the Office of the Engineer prior to Final Acceptance.

3.6 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. The complete electrical installation shall be grounded and bonded in an approved manner per:
 - 1. NFPA 70 – National Electric Code

1.3 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- B. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.
 - 1. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Apache Grounding/Erco Inc.
 - b. Boggs, Inc.
 - c. Chance/Hubbell.
 - d. Copperweld Corp.
 - e. Dossert Corp.
 - f. Erco Inc.; Electrical Products Group.
 - g. Framatome Connectors/Burndy Electrical.
 - h. Galvan Industries, Inc.
 - i. Harger Lightning Protection, Inc.
 - j. Hastings Fiber Glass Products, Inc.
 - k. Heary Brothers Lightning Protection Co.
 - l. Ideal Industries, Inc.
 - m. ILSCO.
 - n. Kearney/Cooper Power Systems.
 - o. Korns: C. C. Korns Co.; Division of Robroy Industries.
 - p. Lightning Master Corp.
 - q. Lyncole XIT Grounding.
 - r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - s. Raco, Inc.; Division of Hubbell.
 - t. Robbins Lightning, Inc.
 - u. Salisbury: W. H. Salisbury & Co.
 - v. Superior Grounding Systems, Inc.
 - w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low Voltage Electrical Power Conductors and Cable."
- B. Material: Copper, No.12 AWG minimum.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, unless otherwise indicated.
- F. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
- G. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.
- F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
 - 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.
- D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- E. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- F. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
- G. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 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-24-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. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

- C. Neutrals and bonding conductors shall be connected together only at the service entrance and where separately derived systems originate.
- D. Separately derived systems shall be securely grounded in accordance with the NEC. If the structural steel is utilized as the ground connection all bolted connections in the path to earth shall be provided with bonding jumpers.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding 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.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Where concentric, eccentric or over-sized knockouts are encountered, a grounding-type insulated bushing shall be provided.

- H. EMT terminals and couplings shall be made utilizing steel-plated hexagonal compression connector. No pot metal, set screw or indented type fitting shall be utilized.
- I. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

- A. 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. 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. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. ERICO International Corporation.
 - c. Thomas & Betts Corporation.
 - d. Unistrut; an Atkore International company.
 - e. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4 unless specifically noted otherwise on the drawings.
 - 3. 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 and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. 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. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. 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 scheduled in NECA 1, where Table 1 lists maximum spacing less than stated in 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. 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.
- C. 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 wood 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: Metal expansion shields and machine screws or standard pre-set inserts.
 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 6. To Light Steel: Machine screws or through bolts.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
 8. Powder actuated fasteners shall be prohibited.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Install anchor bolts according to anchor-bolt manufacturer's written instructions

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
 - 1. Raceways include the following:
 - a. RMC.
 - b. EMT.
 - c. FMC.
 - d. LFMC.
 - e. RNC.
 - f. Wireways.
 - 2. Boxes, enclosures, and cabinets include the following:
 - a. Device boxes.
 - b. Outlet boxes.
 - c. Pull and junction boxes.
 - d. Cabinets and hinged-cover enclosures.
- B. Related Sections include the following:
 - 1. Division 26 Section "BASIC ELECTRICAL MATERIALS AND METHODS" for raceways and box supports.
 - 2. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. LFMC: Liquid tight flexible metal conduit.

- D. RMC: Rigid metal conduit.
- E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

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. Metal Conduit and Tubing:
 - a. Alfex Corp.
 - b. Anamet, Inc.; Anaconda Metal Hose.
 - c. Anixter Brothers, Inc.
 - d. Carol Cable Co., Inc.
 - e. Cole-Flex Corp.

- f. Electri-Flex Co.
 - g. Flexcon, Inc.; Coleman Cable Systems, Inc.
 - h. Grinnell Co.; Allied Tube and Conduit Div.
 - i. Monogram Co.; AFC.
 - j. Spiraduct, Inc.
 - k. Triangle PWC, Inc.
 - l. Wheatland Tube Co.
2. Nonmetallic Conduit and Tubing:
- a. Anamet, Inc.; Anaconda Metal Hose.
 - b. Arnco Corp.
 - c. Breeze-Illinois, Inc.
 - d. Cantex Industries; Harsco Corp.
 - e. Certainteed Corp.; Pipe & Plastics Group.
 - f. Cole-Flex Corp.
 - g. Condux International; Electrical Products.
 - h. Electri-Flex Co.
 - i. George-Ingraham Corp.
 - j. Hubbell, Inc.; Raco, Inc.
 - k. Lamson & Sessions; Carlon Electrical Products.
 - l. R&G Sloan Manufacturing Co., Inc.
 - m. Spiraduct, Inc.
 - n. Thomas & Betts Corp.
3. Conduit Bodies and Fittings:
- a. American Electric; Construction Materials Group.
 - b. Crouse-Hinds; Div. of Cooper Industries.
 - c. Emerson Electric Co.; Appleton Electric Co.
 - d. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - e. Lamson & Sessions; Carlon Electrical Products.
 - f. O-Z/Gedney; Unit of General Signal.
 - g. Scott Fetzer Co.; Adalet-PLM.
 - h. Spring City Electrical Manufacturing Co.
4. Metal Wireways:
- a. Hoffman Engineering Co.
 - b. Keystone/Rees, Inc.
 - c. Square D Co.
5. Boxes, Enclosures, and Cabinets:
- a. American Electric; FL Industries.
 - b. Butler Manufacturing Co.; Walker Division.
 - c. Crouse-Hinds; Div. of Cooper Industries.
 - d. Electric Panelboard Co., Inc.
 - e. Erickson Electrical Equipment Co.
 - f. Hoffman Engineering Co.; Federal-Hoffman, Inc.
 - g. Hubbell Inc.; Killark Electric Manufacturing Co.

- h. Hubbell Inc.; Raco, Inc.
- i. Lamson & Sessions; Carlon Electrical Products.
- j. O-Z/Gedney; Unit of General Signal.
- k. Parker Electrical Manufacturing Co.
- l. Robroy Industries, Inc.; Electrical Division.
- m. Scott Fetzer Co.; Adalet-PLM.
- n. Spring City Electrical Manufacturing Co.
- o. Thomas & Betts Corp.
- p. Woodhead Industries, Inc.; Daniel Woodhead Co.

2.2 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type.
- C. FMC: Zinc-coated steel.
- D. LFMC: Flexible steel conduit with PVC jacket.
- E. Fittings: NEMA FB 1; compression type compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. RNC: NEMA TC 2, Schedule 40 or 80 PVC.
- B. RNC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.4 METAL WIREWAYS

- A. Material: Sheet metal sized and shaped as indicated.
- B. 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.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.5 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1.

- B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- C. Grounding Screw: Provide green grounding screw in all outlet boxes.

2.6 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 ENCLOSURES AND CABINETS

- A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods:
 - 1. Exposed: Schedule 80 PVC.
 - 2. Underground, Single Run: RNC.
 - 3. Underground, Grouped: RNC.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures: NEMA 250, Type 4X.

- B. Indoors: Use the following wiring methods:
 - 1. Exposed: EMT.
 - a. Use of EMT shall be restricted from locations where conduit is susceptible to severe corrosion or severe physical damage.
 - 2. Concealed: EMT.
 - 3. Within Concrete: Rigid steel.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
 - 5. Damp or Wet Locations: Rigid steel conduit.
 - 6. Exposed to Severe Physical Damage: Rigid steel conduit.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size: 3/4-inch trade size.
- C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
- D. 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.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Complete raceway installation before starting conductor installation.
- G. Use temporary closures to prevent foreign matter from entering raceways.
- H. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- I. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- J. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- K. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

- L. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- M. Couplings: Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
 - 3. Where raceway passes over a building expansion joint, a standard "expansion joint fitting" compatible with type of raceway shall be employed.
 - 4. EMT couplings shall be plated steel hexagonal compression type. EMT couplings shall be "concrete tight" where buried in masonry or concrete.
- N. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
 - 1. Rigid steel conduit shall terminate in either a locknut/bushing set, or in a threaded hub.
 - 2. Where concentric, eccentric or over-sized knockouts are encountered, a grounding type insulated bushing shall be provided.
 - 3. EMT couplings shall be plated steel hexagonal compression type. EMT couplings shall be "concrete tight" where buried in masonry or concrete.
- O. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- P. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
- Q. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-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 the boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.

- R. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- S. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- T. Do not install aluminum conduits embedded in or in contact with concrete.
- U. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- V. All conduit installed on the interior of exterior walls be spaced off the interior wall surface a minimum of ¼ inch using clamp-backs or struts.
- W. The electrical guidelines require “All outlet boxes, junction boxes and pull boxes shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme as outlined in Section 26 05 00 “Basic Electrical Materials and Methods”. This includes covers on boxes above lift-out and other type accessible ceilings.”
- X. Junction boxes shall be installed no more than 24-inches above grid ceiling to allow for safe access for maintenance personnel.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Final Acceptance.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- C. Comply with ANSI Z535.4 for safety signs and labels.
- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

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

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay. Provide tape around working space for each electrical panelboard, transfer switch, and fire alarm control panel.

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. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.

2.3 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Securely attached to equipment with self-tapping stainless steel screws; if the sharp end is protected, otherwise rivets shall be used. Minimum letter height shall be 1/2 inch. Nameplate material colors are as follows:

1. 480Y/277V equipment – Black Background with White Letters.
2. 208Y/120V equipment – Blue Background with White Letters.

2.5 CABLE TIES

- A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. Cable Ties: For attaching tags. Use Plenum rated.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways within Buildings: Identify the covers of each Disconnect Switch, junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend, system voltage, and source equipment. System legends shall be as follows:
1. Power. (Panel and circuit)

- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors at all accessible locations (power sources, junction or pull boxes and at utilization equipment terminations) use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for all wire sizes.
 - b. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow
 - 4) Neutral: Gray.
 - c. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - d. Factory applied color coded insulation the entire length of all conductors.
- C. Install instructional sign including the color-code for grounded and ungrounded conductors using engraved labels.
- D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- E. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive vinyl labels with the conductor designation.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
- G. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment.

- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Emergency system boxes and enclosures.
- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Variable-speed controllers.
- i. Push-button stations.
- j. Contactors.

END OF SECTION 260553

SECTION 260574 - ARC-FLASH, PROTECTIVE DEVICE, AND SHORT CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

- a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Comply with IEEE 1584 and NFPA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor designations and kVA ratings.
 - 5. Disconnect designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- F. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Fuses: Show current rating, voltage, and class.

- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - e. Cables and conductors damage curves.
 - f. Ground-fault protective devices.
 - g. Motor-starting characteristics and motor damage points.
 5. Provide adequate time margins between device characteristics such that selective operation is achieved.
 6. Comments and recommendations for system improvements.
- H. Incident Energy and Flash Protection Boundary Calculations:
1. Arcing fault magnitude.
 2. Protective device clearing time.
 3. Duration of arc.
 4. Arc-flash boundary.
 5. Working distance.
 6. Incident energy.
 7. Hazard risk category.
 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.

- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Flash protection boundary.
 - 4. Hazard risk category.
 - 5. Incident energy.
 - 6. Working distance.
 - 7. Available fault current.
 - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to studies may not be used in studies.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. Include all 3-phase large disconnect switches that are included in the Chiller Addition.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and shall apply to low- and medium-voltage, three-phase ac systems.

- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Large disconnects.

3.3 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.
- C. Calculate fault-current size based on utility furnished available fault current data.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors shall be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors should be decayed to match the actual decrement of each as closely as possible.
- G. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. The contractor shall model protective devices for the chillers to include in the report. Selective coordination with utility overcurrent protection is not required.
- B. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- C. Comply with IEEE 399 for general study procedures.

- D. The study shall be based on the device characteristics supplied by device manufacturer.
- E. The extent of the electrical power system to be studied is indicated on Drawings.
- F. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. Include all 3-phase large disconnect switches that are included in the Chiller Addition.
- G. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- H. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- I. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
- J. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
- L. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of bus bars to withstand short-circuit stresses.

3.5 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Engineer.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
 - 5. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 - 6. Motor horsepower and NEMA MG 1 code letter designation.
 - 7. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.6 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

3.7 LABELING

- A. Apply one arc-flash label for 3-phase disconnects.

3.8 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

END OF SECTION 260574

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.
- B. Ambient Temperature Adjustment Information. If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses adjusted.
 - 1. For each adjusted fuse, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Third party agencies shall be amongst those accredited by the NCBC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 10 percent of each fuse type and size, but not fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.; Bussmann Div.
 - 2. Eagle Electric Mfg. Co., Inc.
 - 3. Ferraz Corp.
 - 4. General Electric Co.; Wiring Devices Div.
 - 5. Gould Shawmut.
 - 6. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Motor Branch Circuits: Class RK1, time delay.
- B. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262819 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes individually mounted switches and circuit breakers used for the following:
 - 1. Motor disconnect switches.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 26 Section "Fuses" for fuses in fusible disconnect switches.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.
- C. Product Data for switches, and accessories specified in this Section. Include the following:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for circuit breakers with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.
- D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.
- E. Field test reports indicating and interpreting test results.
- F. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

- B. Comply with NFPA 70 for components and installation.
- C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide disconnect switches by one of the following:
 - 1. Disconnect Switches:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. GE/ABB; Electrical Distribution & Control Div.
 - c. Siemens Energy & Automation, Inc.
 - d. Schneider Electric; Square D

2.2 DISCONNECT SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 4X.
 - 2. Other Wet or Damp Indoor Locations: Type 4.
- D. Disconnect switches serving VFD driven motors: Provide and "break-before-break" disconnect containing an auxiliary contact to provide a signal to the VFD that the motor disconnect is being turned off. Provide an additional 3/4" C and 24 VDC wiring between disconnect and VFD for auxiliary signal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches in locations as indicated, according to manufacturer's written instructions.
- B. Install disconnect switches level and plumb.
- C. Install wiring between disconnect switches, control, and indication devices.
- D. Connect disconnect switches and components to wiring system and to ground as indicated and instructed by manufacturer.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Identify each disconnect switch according to requirements specified in Division 26 Section "Basic Electrical Materials and Methods."

3.2 FIELD QUALITY CONTROL

- A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches. Certify compliance with test parameters.
- B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 262819

SECTION III

TERMS AND CONDITIONS FOR SERVICES, CONSTRUCTION OR THE PURCHASE OF

APPARATUS, SUPPLIES, MATERIALS, LABOR AND EQUIPMENT

These Terms and Conditions, made and entered into on this the ____ day of _____, by and between GREENVILLE UTILITIES COMMISSION OF THE CITY OF GREENVILLE, PITT COUNTY, NORTH CAROLINA, with one of its principal offices and places of business at 401 S. Greene Street, Post Office Box 1847, Greenville, Pitt County, North Carolina 27835-1847, hereinafter referred to as "GUC" and _____, a _____ organized and existing under and by virtue of the laws of the State of _____, with one of its principal offices and places of business at _____, hereinafter referred to as "PROVIDER";

1.0 TAXES

No taxes shall be included in any bid prices. GUC is exempt from Federal Excise Tax. GUC is not exempt from North Carolina state sales and use tax or, if applicable, Pitt County sales and use tax. Such taxes shall be shown as a separate item on the invoice.

2.0 INVOICES

It is understood and agreed that orders will be shipped at the established contract prices and quantities in effect on dates orders are placed. Invoicing at variance with this provision may subject the contract to cancellation. Applicable North Carolina sales tax shall be invoiced as a separate line item. All invoices must bear the GUC purchase order number. Mail all invoices to Greenville Utilities Commission, Finance Department, P. O. Box 1847, Greenville, NC 27835-1847.

3.0 PAYMENT TERMS

Payments for equipment, materials, or supplies will be made after the receipt and acceptance of the equipment, materials, supplies or services and after submission of a proper invoice. GUC's normal payment policy is thirty (30) days. GUC will not be responsible for any goods delivered without a purchase order having been issued. Payment will be made in U. S. currency only.

4.0 QUANTITIES

Quantities specified are only estimates of GUC's requirements. GUC reserves the right to purchase more or less than the stated quantities at prices indicated in the submitted Proposal Form based on our actual needs.

5.0 AFFIRMATIVE ACTION

The Provider will take affirmative action in complying with all Federal and State requirements concerning fair employment and employment of the handicapped, and concerning the treatment of all employees, without discrimination by reason of race, color, religion, sex, national origin, or physical handicap.

6.0 CONDITION AND PACKAGING

Unless otherwise indicated in the bid, it is understood and agreed that any item offered or shipped shall be new and in first class condition, that all containers shall be new and suitable for storage or shipment, and that prices include standard commercial packaging.

7.0 SAMPLES

Samples of items, if required, must be furnished free of expense to GUC, and if not destroyed, will, upon request, be returned at the Provider's expense. Request for the return of samples must be made at the bid opening, otherwise, the samples will become GUC's property. Each individual sample must be labeled with Provider's name.

8.0 SPECIFICATIONS

Any deviation from specifications must be clearly pointed out, otherwise, it will be considered that items offered are in strict compliance with specifications, and the Provider will be held responsible. Deviations must be explained in detail. **The Provider shall not construe this paragraph as inviting deviation or implying that any deviation will be acceptable.**

9.0 INFORMATION AND DESCRIPTIVE LITERATURE

Providers are to furnish all information requested. Further, as may be specified elsewhere, each Provider must submit with its proposal: cuts, sketches, descriptive literature, and/or complete specifications covering the products offered. Reference to literature submitted with a previous bid does not satisfy this provision. Bids which do not comply with these requirements will be subject to rejection.

10.0 AWARD OF CONTRACT

As directed by statute, qualified bids will be evaluated and acceptance made of the lowest responsible, responsive bid most advantageous to GUC as determined upon consideration of such factors as prices offered, the quality of the article(s) offered, the general reputation and performance capabilities of the Provider, substantial conformity with the specifications and other conditions set forth in the bid, the suitability of the article(s) for the intended use, the related services needed, the date(s) of delivery and performance, and such other factors deemed by GUC to be pertinent or peculiar to the purchase in question.

Acceptance of the order includes acceptance of all terms, conditions, prices, delivery instructions, and specifications as shown on this set of Terms and Conditions and in this order or attached to and made a part of this order.

The conditions of this order cannot be modified except by written amendment in the form of "Amended Purchase Order," which has been approved by GUC's Procurement Manager.

In the event of a Provider's failure to deliver or perform as specified, GUC reserves the right to cancel the order or any part thereof, without prejudice to GUC's other rights. The Provider agrees that GUC may return part of or all of any shipment at Provider's expense. GUC may charge the Provider with all reasonable expenses resulting from such failure to deliver or perform.

11.0 MEDIATION/BINDING ARBITRATION

In the event of any dispute between the Parties, the Parties agree to submit any dispute to non-binding mediation before a mutually agreeable Mediator prior to initiating litigation. If the Parties are unable to agree upon a Mediator within thirty (30) days after demand therefore, either Party may petition a Court of competent jurisdiction for the designation of a qualified Mediator for these purposes. Each Party shall bear its own costs and expenses of participating in the mediation (including, without limitation, reasonable attorneys' fees), and each Party shall bear one-half (1/2) of the costs and expenses of the Mediator. Unless otherwise agreed, the Parties will hold the mediation in Greenville, North Carolina. The matters discussed or revealed in the mediation session shall not be disclosed in any subsequent litigation.

In the event the matter is not resolved in mediation, either Party may request arbitration. The parties shall jointly select an Arbitrator, and shall be bound by the decision of the Arbitrator with respect to any dispute between the parties with respect to this Agreement. If the parties are unable to mutually agree upon an Arbitrator, the Parties shall each select an Arbitrator, and the two Arbitrators so selected shall select a third Arbitrator, and the decision of the majority of the Arbitrators shall be conclusive and binding upon the Parties. The Parties at all times agree to equally split the costs of any Arbitrator(s) selected in an effort to resolve the dispute between the Parties. Any party desiring to resolve a dispute under the terms of this Agreement shall notify the other Party in writing, and the Parties shall seek to agree upon a mutually agreed-upon Arbitrator within a period of ten (10) days from the date of such written demand. If the Parties are unable to agree within such ten (10) day period, the Parties shall each select an Arbitrator, and the two (2) Arbitrators so selected shall select a third Arbitrator within fifteen (15) days from the date of the written demand for arbitration, and a decision shall be rendered by the Arbitrator(s) so selected within five (5) days after such Arbitrator(s) is selected.

12.0 GOVERNMENT RESTRICTIONS

In the event any Governmental restrictions may be imposed which would necessitate alteration of the material, quality, workmanship, or performance of the items offered on this bid prior to their delivery, it shall be the responsibility of the successful Provider to notify the GUC Procurement Manager, at once, indicating in its letter the specific regulation which required such alterations. GUC reserves the right to accept any such alterations, including any price adjustments occasioned thereby, or, in the sole discretion of GUC, to cancel the contract.

13.0 INSURANCE

13.1 Coverage – During the term of the contract, the Provider at its sole cost and expense shall provide commercial insurance of such type and with the following coverage and limits:

13.1.1 Workers' Compensation – The Provider shall provide and maintain Workers' Compensation Insurance, as required by the laws of North Carolina, as well as employer's liability coverage with minimum limits of \$1,000,000 each accident, covering all Provider's employees who are engaged in any work under the contract. If any work is sublet, the Provider shall require the subcontractor to provide the same coverage for any of its employees engaged in any work under the contract.

13.1.2 General Liability – Commercial Liability Coverage written on an “occurrence” basis in the minimum amount of \$1,000,000 per occurrence.

13.1.3 Automobile – Automobile Liability Insurance, to include coverage for all owned, hired, and non-owned vehicles used in connection with the contract with a minimum combined single limit of \$1,000,000 per accident.

13.2 Requirements - Providing and maintaining adequate insurance coverage is a material obligation of the Provider. All such insurance shall meet all laws of the State of North Carolina. Such insurance coverage shall be obtained from companies that are authorized to provide such coverage and that are authorized to do business in North Carolina by the Commissioner of Insurance. The Provider shall at all times comply with the terms of such insurance policies and all requirements of the insurer under any of such insurance policies, except as they may conflict with existing North Carolina laws or this contract. The limits of coverage under each insurance policy maintained by the Provider shall not be interpreted as limiting the Provider’s liability and obligations under the contract. It is agreed that the coverage as stated shall not be canceled or changed until thirty (30) days after written notice of such termination or alteration has been sent by registered mail to GUC’s Procurement Manager.

14.0 PATENTS AND COPYRIGHTS

The Provider shall hold and save GUC, its officers, agents, and employees, harmless from liability of any kind, including costs and expenses, including reasonable attorney fees, on account of any copyrighted articles or any patented or unpatented invention, device or appliance manufactured or used in the performance of this contract.

15.0 PATENT AND COPYRIGHT INDEMNITY

The Provider will defend or settle, at its own expense, any action brought against GUC to the extent that it is based on a claim that the product(s) provided pursuant to this agreement infringe any U.S. copyright or patent; and will pay those costs, damages, and attorney fees finally awarded against GUC in any such action attributable to any such claim, but such defense, settlements, and payments are conditioned on the following: (1) that Provider shall be notified promptly in writing by GUC of any such claim; (2) that Provider shall have sole control of the defense of any action on such claim and of all negotiations for its settlement or compromise; (3) that GUC shall cooperate with Provider in a reasonable way to facilitate the settlement of defense of such claim; (4) that such claim does not arise from GUC modifications not authorized by the Provider or from the use of combination of products provided by the Provider with products provided by GUC or by others; and (5) should such product(s) become, or in the Provider’s opinion likely to become, the subject of such claim of infringement, then GUC shall permit Provider, at Provider’s option and expense, either to procure for GUC the right to continue using the product(s), or replace or modify the same so that it becomes non-infringing and performs in a substantially similar manner to the original product.

16.0 EXCEPTIONS

All proposals are subject to the terms and conditions outlined herein. All responses will be controlled by such terms and conditions and the submission of other terms and conditions, price catalogs, and other documents as part of a Provider’s response will be waived and have no

effect on this Request for Proposal or any other contract that may be awarded resulting from this solicitation. The submission of any other terms and conditions by a Provider may be grounds for rejection of the Provider's proposal. The Provider specifically agrees to the terms and conditions set forth in this set of Terms and Conditions by affixing its name on the signatory page contained herein.

17.0 CONFIDENTIAL INFORMATION

Except as provided by statute and rule of law, GUC will keep trade secrets which the Provider does not wish disclosed confidential. Each page shall be identified in boldface at the top and bottom as "CONFIDENTIAL" by the Provider. Cost information shall not be deemed confidential. The determination of whether a matter is confidential will be determined by North Carolina law.

18.0 ASSIGNMENT

No assignment of the Provider's obligations or the Provider's right to receive payment hereunder shall be permitted without the express written consent of GUC, provided however, upon written request approved by the GUC Procurement Manager, solely as a convenience to the Provider, GUC may:

- Forward the Provider's payment check directly to any person or entity designated by the Provider, and
- Include any person or entity designated by Provider as a joint payee on the Provider's payment check.
- In no event shall such approval and action obligate GUC to anyone other than the Provider, and the Provider shall remain responsible for fulfillment of all contract obligations.

19.0 ACCESS TO PERSON AND RECORDS

GUC shall have reasonable access to persons and records of Provider as a result of all contracts entered into by GUC.

20.0 INSPECTION AT BIDDER'S SITE

GUC reserves the right to inspect, at a reasonable time, the item, plant, or other facilities of a prospective Provider prior to contract award and during the contract term as necessary for GUC's determination that such item, plant, or other facilities conform with the specifications/requirements and are adequate and suitable for the proper and effective performance of the contract. Provider may limit GUC's access to restricted areas.

21.0 AVAILABILITY OF FUNDS

Any and all payments of compensation of this specific transaction and any continuation or any renewal or extension are dependent upon and subject to the allocation of GUC funds for the purpose set forth in this Agreement.

22.0 GOVERNING LAWS

All contracts, transactions, agreements, etc., are made under and shall be governed by and construed in accordance with the laws of the State of North Carolina.

23.0 ADMINISTRATIVE CODE

Bids, proposals, and awards are subject to applicable provisions of the North Carolina Administrative Code and General Statutes and Laws of the State of North Carolina.

24.0 EXECUTION

In the discretion of GUC, failure of a duly authorized official of Provider to sign the Signatory Page may render the bid invalid.

25.0 CLARIFICATIONS/INTERPRETATIONS

Any and all questions regarding these Terms and Conditions must be addressed to the GUC Procurement Manager. Do not contact the user directly. **These Terms and Conditions are a complete statement of the parties' agreement and may only be modified in writing signed by Provider and the GUC Procurement Manager.**

26.0 SITUS

The place of all contracts, transactions, agreements, their situs and forum, shall be North Carolina, where all matters, whether in contract or tort, relating to the validity, construction, interpretation, and enforcement shall be determined.

27.0 TERMINATION OF AGREEMENT

GUC or Provider may terminate this Agreement for just cause at any time. Provider will be paid for all time and expenses incurred as of the termination date. Termination for just cause by either party shall be by certified letter and shall be effective thirty (30) days after signed and acknowledged receipt of said letter. Just cause shall be based on reasonable grounds, and there must be a fair and honest cause or reason for such action. The causes for termination, include, but are not limited to: (1) Provider's persistent failure to perform in accordance with the Terms and Conditions, (2) Provider's disregard of laws and regulations related to this transaction, and/or (3) Provider's substantial violation of the provisions of the Terms and Conditions.

28.0 DELIVERY

Shipments will be made only upon releases from a purchase order issued by GUC in accordance with GUC's current needs.

Time is of the essence with respect to all deliveries under this Agreement.

Delivery of all equipment, materials, or supplies shall be made Free on Board (FOB) GUC Warehouse, 701 Utility Way, Greenville, North Carolina 27834, unless otherwise specified. The agreed price for such equipment, materials, or supplies shall include all costs of delivery and ownership, and risks of loss shall not be transferred from Provider to GUC until express written acceptance of delivery and inspection by GUC. Delivery hours are between 8:00 AM and 4:30 PM Monday-Friday only. **GUC's purchase order number is to be shown on the packing slip**

or any related documents. GUC reserves the right to refuse or return any delivery with no purchase order number or which is damaged. GUC will not be charged a restocking fee for any delivery which is refused or returned.

29.0 INDEMNITY PROVISION

Provider agrees to indemnify and save GREENVILLE UTILITIES COMMISSION of the City of Greenville, Pitt County, North Carolina, and the City of Greenville, North Carolina, its co-owners, joint venturers, agents, employees, and insurance carriers harmless from any and all losses, claims, actions, costs, expenses including reasonable attorney fees, judgments, subrogations, or other damages resulting from injury to any person (including injury resulting in death), or damage (including loss or destruction) to property of whatsoever nature of any person arising out of or incident to the performance of the terms of this Contract by Provider, including, but not limited to, Provider's employees, agents, subcontractors, and others designated by Provider to perform work or services in, about, or attendant to, the work and services under the terms of this Contract. Provider shall not be held responsible for any losses, expenses, claims, subrogations, actions, costs, judgments, or other damages, directly, solely, and proximately caused by the negligence of Greenville Utilities Commission of the City of Greenville, Pitt County, North Carolina. Insurance covering this indemnity agreement by the Provider in favor of Greenville Utilities Commission of the City of Greenville, Pitt County, North Carolina, and the City of Greenville, North Carolina, shall be provided by Provider.

30.0 FORCE MAJEURE

Neither party shall be considered in default in the performance of its obligations hereunder to the extent that the performance of any such obligation is prevented or delayed by any cause, existing or future, which is beyond the reasonable control of such party. In any such event of force majeure, the parties shall advise each other of such event, and the parties shall negotiate an equitable adjustment to their respective obligations under this Agreement.

31.0 WARRANTY(IES)

The Provider hereby includes all warranties, whether expressed or implied, including, but not limited to, the Implied Warranty of Merchantability and the Implied Warranty of Fitness for a Particular Purpose.

32.0 INTEGRATED CONTRACT

These Terms and Conditions, Instructions to Bidders, Specifications, and the selected Provider's bid represents the entire contract between the Parties. No verbal or other written agreement(s) shall be held to vary the provisions of this Agreement.

33.0 CONTRACT PROVISIONS

Each of the provisions of these Terms and Conditions shall apply to the full extent permitted by law, and the invalidity in whole or in part of any provision shall not affect the remainder of such provision or any other provisions.

34.0 E-VERIFY

E-Verify - I understand that E-Verify is the federal E-Verify program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law in accordance with NCGS §64-25 et seq. I am aware of and in compliance with the requirements of E-Verify and Article 2 of Chapter 64 of the North Carolina General Statutes. To the best of my knowledge, any subcontractors employed by me as a part of this contract are in compliance with the requirements of E-Verify and Article 2 of Chapter 64 of the North Carolina General Statutes.

35.0 IRAN DIVESTMENT ACT CERTIFICATION

By acceptance of this purchase order, Vendor/Contractor certifies that, as of the date of the purchase order or contract, it is not on the Final Divestment List as created by the State Treasurer pursuant to N.C.G.S. § 143-6A-4. In compliance with the requirements of the Iran Divestment Act and N.C.G.S. § 143C-6A-5(b), Vendor/Contractor shall not utilize in the performance of the contract any subcontractor that is identified on the Final Divestment List.

36.0 UNIFORM GUIDANCE

Contracts funded with federal grant or loan funds must be procured in a manner that conforms with all applicable federal laws, policies, and standards, including those under the Uniform Guidance (2 C.F.R. Part 200).

37.0 SAFETY STATEMENTS

Safety Culture Commitment Statement:

At Greenville Utilities, we are committed to a culture of safety that prioritizes the well-being of our employees, contractors, and the communities we serve.

We believe that everyone deserves to work in a safe environment, and we are dedicated to fostering a culture where **safety is a core value, not just a priority.**

Here's what that means to us:

- **Employee and Contractor Safety:** We are committed to providing a safe work environment for all employees and contractors. We will invest in safety training, resources, and equipment to prevent accidents and injuries.
- **Open Communication:** We encourage open and honest communication about safety concerns. We believe everyone has a right and responsibility to speak up about unsafe work practices and potential hazards.
- **Continuous Improvement:** We are committed to continuous improvement in safety performance. We will learn from incidents and near misses, and we will actively seek ways to improve our safety processes and procedures.
- **Accountability:** We hold ourselves and our contractors accountable for safe work practices. This includes providing clear safety expectations, enforcing safety rules, and recognizing safe behavior.
- **Collaboration:** We believe in working collaboratively with employees, contractors, and regulatory agencies to achieve the highest level of safety.

Our commitment to safety extends beyond our employees. We work closely with our contractors to ensure they share our safety values. We expect them to implement robust safety programs, train their workers thoroughly, and adhere to all safety regulations.

We are confident that by working together, we can create a culture of safety where everyone goes home safe and healthy every day.

This commitment statement is a public declaration of our unwavering dedication to safety. We will continue to strive for zero incidents while promoting a positive safety culture that prioritizes the well-being of everyone involved in our utility operations.

Safety Management System Commitment Statement:

At Greenville Utilities, we are unwavering in our commitment to delivering safe and reliable utility service through a robust Safety Management System (SMS). This system forms the foundation of our safety culture, ensuring the well-being of our employees, contractors, and the communities we serve.

Our SMS commitment emphasizes:

- **Zero Incidents:** We believe all incidents are preventable. We strive for zero incidents by proactively managing risks and continuously improving our safety practices.
- **Empowered Workforce:** We foster a culture where safety is everyone's responsibility. This includes providing comprehensive safety training for both employees and contractors, empowering them to identify and report hazards.
- **Data-Driven Decisions:** We utilize data from inspections, incident investigations, and performance metrics to make informed decisions for risk mitigation and continuous improvement of our SMS.
- **Leadership Engagement:** Our leadership team actively demonstrates a commitment to safety by participating in safety reviews, audits, and promoting safety as a core value.
- **Contractor Collaboration:** We extend our safety commitment to our contractors. We require contractors working on our system to adhere to SMS principles, participate in safety briefings, and maintain strong safety programs within their own organizations.
- **Transparent Communication:** We believe in open communication about safety. We encourage employees and contractors to report concerns without fear of reprisal. We also maintain transparent communication with stakeholders about SMS performance.

This SMS commitment is a continuous journey, not a destination. We are dedicated to regularly reviewing and updating our system to reflect best practices and emerging technologies. Through continuous improvement and a commitment to a positive safety culture, we aim to remain an industry leader in safe and reliable utility service.

38.0 NOTICES

Notices to the Parties should be sent to the names and addresses specified below:

Cleve Haddock, Lifetime CLGPO
Procurement Manager
Greenville Utilities Commission
P.O. Box 1847
Greenville, NC 27835-1847

Vendor Specified on Page 1 of Section III when awarded.

GREENVILLE UTILITIES COMMISSION

By: _____
Anthony C. Cannon

Title: General Manager/CEO
(Authorized Signatory)

Date: _____

Attest: _____

Name (Print): Amy Wade

Title: Executive Secretary

Date: _____

(OFFICIAL SEAL)

COMPANY NAME:

By: _____

Name (Print): _____

Title: _____
(Authorized Signatory)

Date: _____

Attest: _____

Name (Print): _____

Title: Corporate Secretary

Date: _____

(CORP. SEAL)

APPROVED AS TO FORM AND LEGAL CONTENT:

By: _____
Phillip R. Dixon

Title: General Counsel

Date: _____

401 SOUTH GREENE STREET
GREENVILLE, NC 27858



SHEET NUMBER		SHEET NAME
00 - General		
G001	COVER SHEET	
G002	APPENDIX B SHEET	
Architectural		
A1.1	DEMOLITION REFLECTED CEILING PLAN & NOTES	
A1.2	RENOVATION REFLECTED CEILING PLAN & NOTES	
A1.3	DEMOLITION REFLECTED CEILING PLAN & NOTES	
A1.4	RENOVATION REFLECTED CEILING PLAN & NOTES	
A1.5	DEMOLITION/RENOVATION FLOOR PLAN & NOTES	
Mechanical		
M001	MECHANICAL LEGEND, NOTES AND ABBREVIATIONS	
MD101-1	MECHANICAL DUCTWORK DEMO PLAN - LEVEL 3 - PHASE I	
MD102-1	MECHANICAL DUCTWORK DEMO PLAN - ROOF - PHASE I	
MD201-1	MECHANICAL PIPING DEMO PLAN - LEVEL 3 - PHASE I	
M101-1	MECHANICAL DUCTWORK PLAN - LEVEL 3 - PHASE I	
M102-1	MECHANICAL DUCTWORK PLAN - ROOF - PHASE I	
M201-1	MECHANICAL PIPING PLAN - LEVEL 3 - PHASE I	
M202-1	MECHANICAL PIPING PLAN - ROOF - PHASE I	
MD101-2	MECHANICAL DUCTWORK DEMO PLAN - LEVEL 2 - PHASE II	
MD102-2	MECHANICAL DUCTWORK DEMO PLAN - ROOF - PHASE II	
MD202-2	MECHANICAL PIPING DEMO PLAN - ROOF - PHASE II	
M101-2	MECHANICAL DUCTWORK PLAN - LEVEL 2 - PHASE II	
M102-2	MECHANICAL DUCTWORK PLAN - ROOF - PHASE II	
M202-2	MECHANICAL STRUCTURAL COORDINATION PLAN - ROOF - PHASE II	
M201-2	MECHANICAL PIPING PLAN - LEVEL 2 - PHASE II	
M202-2	MECHANICAL PIPING PLAN - ROOF - PHASE II	
M401	MECHANICAL RISERS AND FLOW DIAGRAMS	
M501	MECHANICAL DETAILS	
M502	MECHANICAL DETAILS	
M503	MECHANICAL DETAILS	
M601	MECHANICAL CONTROLS	
M602	MECHANICAL CONTROLS	
M701	MECHANICAL SCHEDULES	
Electrical		
E001	ELECTRICAL LEGEND, NOTES AND ABBREVIATIONS	
ED100-DEM	ELECTRICAL POWER DEMO PLAN - LEVEL 4 - PHASE I	
ED105-DEM	ELECTRICAL POWER DEMO PLAN - LEVEL 4 - PHASE II	
E101	ELECTRICAL POWER PLAN - LEVEL 1	
E102	ELECTRICAL POWER PLAN - LEVEL 2	
E103	ELECTRICAL POWER PLAN - LEVEL 3	
E104	ELECTRICAL POWER PLAN - LEVEL 4 - PHASE I	
E105	ELECTRICAL POWER PLAN - LEVEL 4 - PHASE II	
E202	ELECTRICAL LIGHTING CEILING PLAN - LEVEL 2	
E203	ELECTRICAL LIGHTING CEILING PLAN - LEVEL 3	
E301	ELECTRICAL DETAILS	
E801	ELECTRICAL SCHEDULES	

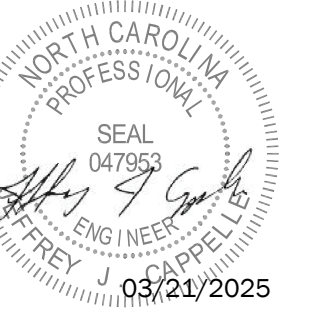
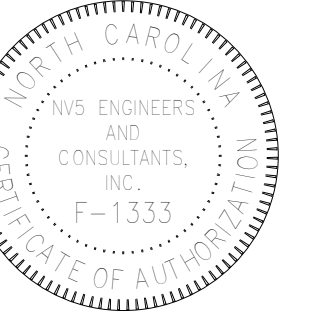


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3/21/2025 11:32:10 AM

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CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN

[illegible]

PROJECT NO.:	24-0006120
DESIGNED BY:	Designer
CHECKED BY:	Checker
DATE:	03/21/2025
SCALE:	NTS

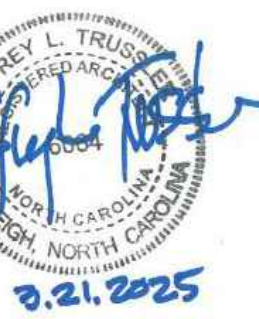
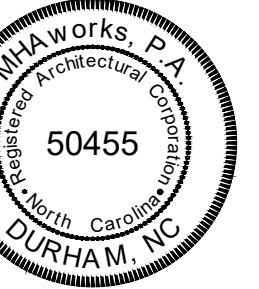
SHEET NAME

COVER SHEET

SHEET NUMBER

G001

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CONSULTANT



PROJECT NAME

**GUC Admin Building
HVAC Upgrades**
Greenville, North Carolina

KEY PLAN

PROJECT NO.: 24125

DESIGNED BY: RLW

CHECKED BY:

DATE: 3/21/2025

SCALE:

SHEET NAME

Demolition Reflected Ceiling Plan & Notes

SHEET NUMBER

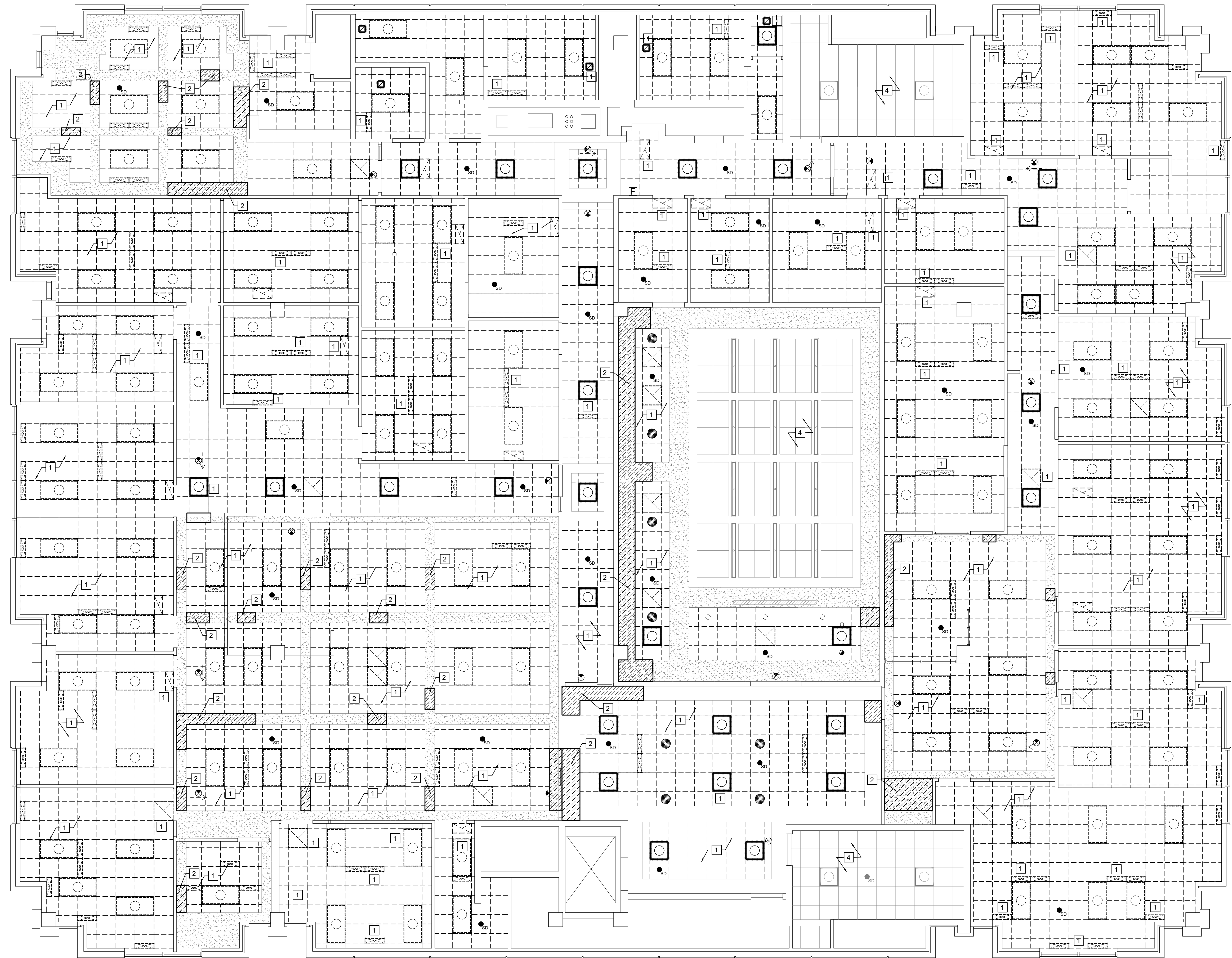
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GENERAL DEMOLITION NOTES

1. GUC SHALL PERFORM HAZARDOUS MATERIAL TESTING AND PROVIDE THE REPORT SO IT CAN BE INCORPORATED INTO THE SPECIFICATION MANUAL FOR THE GC TO REVIEW. THE GC SHALL BE RESPONSIBLE FOR ANY REQUIRED ABATEMENT.
2. ALL DEMOLITION IS TO BE LIMITED TO THE EXTENT REQUIRED FOR NEW WORK. PROTECT ALL ITEMS AND EXISTING SURFACES TO REMAIN FROM DAMAGE AS REQUIRED FOR EACH PHASE.
3. ANY ADJACENT SURFACE THAT IS DISTURBED BY NEW CONSTRUCTION SHALL BE PATCHED, REPAIRED, PRIMED, PAINTED, ETC. TO MATCH EXISTING CONDITIONS.
4. DISPOSE OF ALL DEBRIS AND WASTE MATERIAL IN APPROPRIATE LANDFILL AT CONTRACTOR'S EXPENSE. RETAIN ALL DISPOSAL RECORDS.
5. DEMOLITION IS TO INCLUDE BUT IS NOT LIMITED TO, ITEMS DASHED ON THE DRAWINGS AND AS NOTED IN KEYED DEMOLITION NOTES.
6. EXISTING CEILING FIXTURES (INCLUDING LIGHTS, SPRINKLER HEADS, SMOKE DETECTORS, SPEAKERS ETC.) TO BE PROTECTED DURING CONSTRUCTION & WILL BE REINSTALLED UNLESS NOTED OTHERWISE.
7. COORDINATE DEMOLITION AND PREPARATION OF PLUMBING, HVAC, ELECTRICAL, TELE, AND DATA ITEMS WITH PME DRAWINGS.
8. REFER TO RENOVATIONS SHEETS FOR NEW WORK.

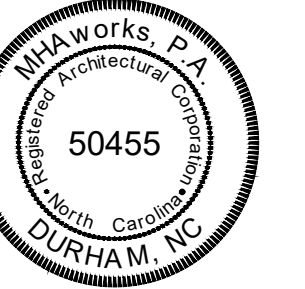
KEYED DEMOLITION NOTES

- 1 DEMOLISH CEILING TILE AS SHOWN. PROTECT ALL LIGHTS & CEILING FIXTURES; TO BE REINSTALLED.
- 2 DEMOLISH PORTION OF SOFFIT AS SHOWN.
- 3 REMOVE EXISTING LOUVER & REPLACE W/ NEW METAL DOOR. INFILL ANY GAPS AND SEAL FOR WEATHERPROOFING AS NEEDED.
- 4 EXISTING TO REMAIN.
- 5 NEW WALL PENETRATION & LINTEL FOR DUCT PENETRATION. SEE MECHANICAL DRAWINGS.



Demolition Reflected Ceiling Plan - Level 2 - Phase II ①
3/16"=1'-0"

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9/21/2025

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CLIENT

CONSULTANT



PROJECT NAME

**GUC Admin Building
HVAC Upgrades**
Greenville, North Carolina

KEY PLAN

PROJECT NO.: 24125

DESIGNED BY: RLW

CHECKED BY:

DATE: 3/21/2025

SCALE:

SHEET NAME

Renovation Reflected Ceiling Plan & Notes

SHEET NUMBER

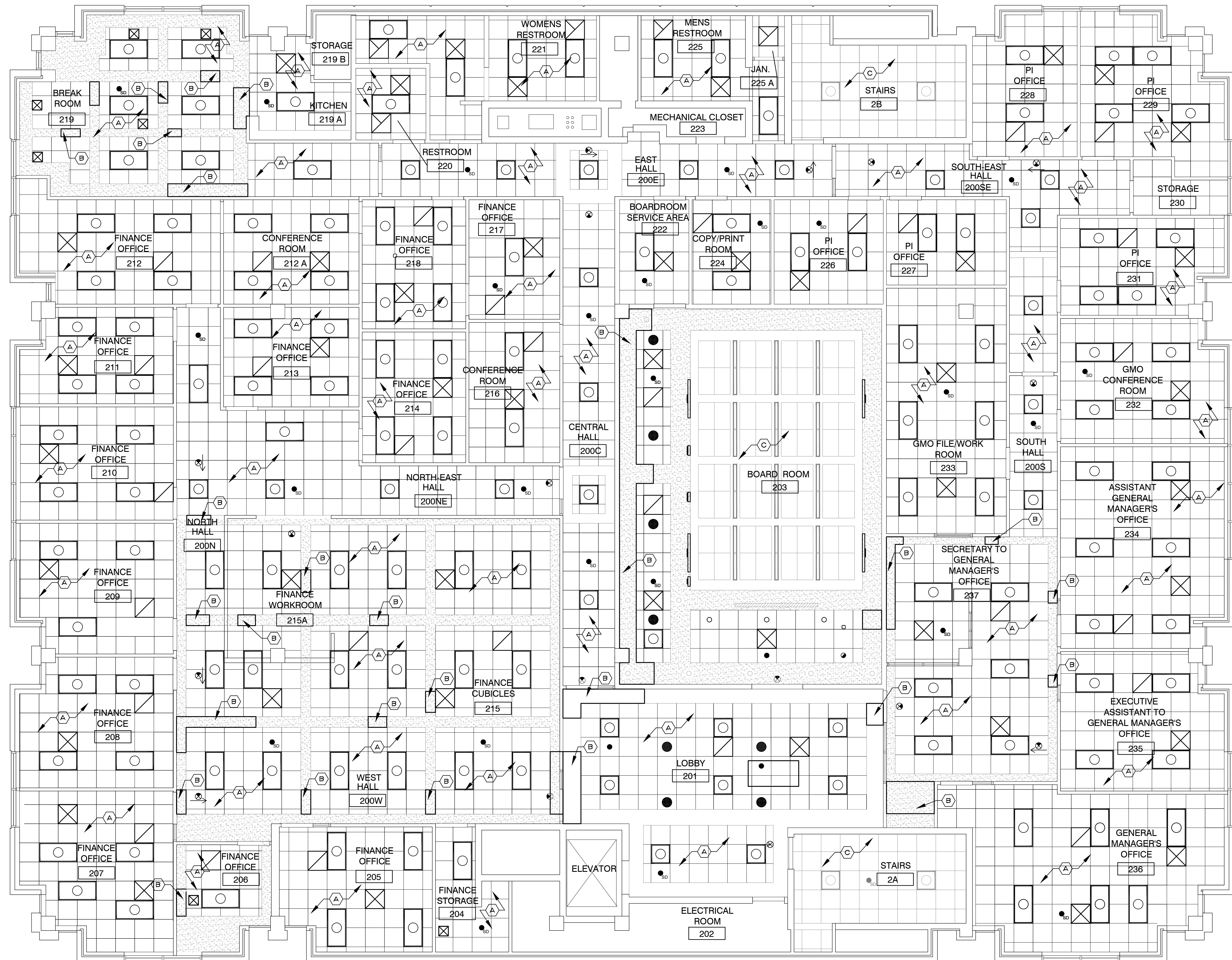
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GENERAL NOTES

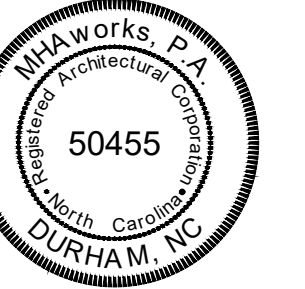
- G.C. SHALL VERIFY ALL EXISTING CONDITIONS PRIOR TO DEMOLITION, CONSTRUCTION OR FABRICATION. ALL WORK SHALL BE IN STRICT ACCORDANCE WITH THE NC BUILDING CODE. THE G.C. SHALL NOTIFY THE ARCHITECT AND ECU IN WRITING REGARDING ANY DISCREPANCIES ON THE PLANS. IF REQUIRED, G.C. IS RESPONSIBLE FOR PERMITS, INSPECTIONS, AND FEES.
- FINAL CLEANING OF THE BUILDING SHALL BE BY THE G.C. PRIOR TO OCCUPANCY.
- G.C. SHALL LOCATE ALL UTILITIES IN THE WORK AREA PRIOR TO PROCEEDING WITH WORK AND COORDINATE ALL UTILITY OUTAGES WITH GUC AS PER GUC'S REQUIREMENTS.
- DO NOT SCALE DRAWINGS. WRITTEN DIMENSIONS GOVERN IN CASE OF CONFLICT. CONSULT THE ARCHITECT FOR DIRECTION.
- G.C. SHALL COORDINATE WORK HOURS WITH GUC.
- G.C. SHALL COORDINATE WITH GUC FOR THE PROTECTION AND STORAGE OF ALL PRODUCTS REQUIRED TO PERFORM THE WORK DESCRIBED IN THE CONTRACT DOCUMENTS.
- GUC WILL DESIGNATE/CONFIRM PARKING, LAY DOWN AREAS, AND ENTRANCES TO THE PROJECT SITE FOR THE G.C.'S USE.
- G.C. SHALL MAINTAIN UNIMPEDED MEANS OF EGRESS WHEN BUILDING IS IN USE.
- ALL LIGHTING AND CEILING FIXTURES TO REMAIN IN PLACE OR TO BE REINSTALLED.
- REFER TO SPEC BOOK FOR FINISHES.
- STACK AND STORE SALVAGED CEILING TILE FOR FUTURE PATCH & REPAIR.

KEYED RENOVATION NOTES

- (A) NEW CEILING TILE & GRID. REINSTALL EXISTING LIGHTS & CEILING MOUNTED ITEMS. NEW HVAC GRILLES TO BE INSTALLED.
- (B) PATCH & REPAIR SOFFITS AS NEEDED.
- (C) EXISTING CEILING.
- (D) NEW HVAC GRILLE.



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CONSULTANT



PROJECT NAME

**GUC Admin Building
HVAC Upgrades**
Greenville, North Carolina

KEY PLAN

PROJECT NO.: **24125**

DESIGNED BY: **RLW**

CHECKED BY:

DATE: **3/21/2025**

SCALE:

SHEET NAME

Demolition Reflected Ceiling Plan & Notes

SHEET NUMBER

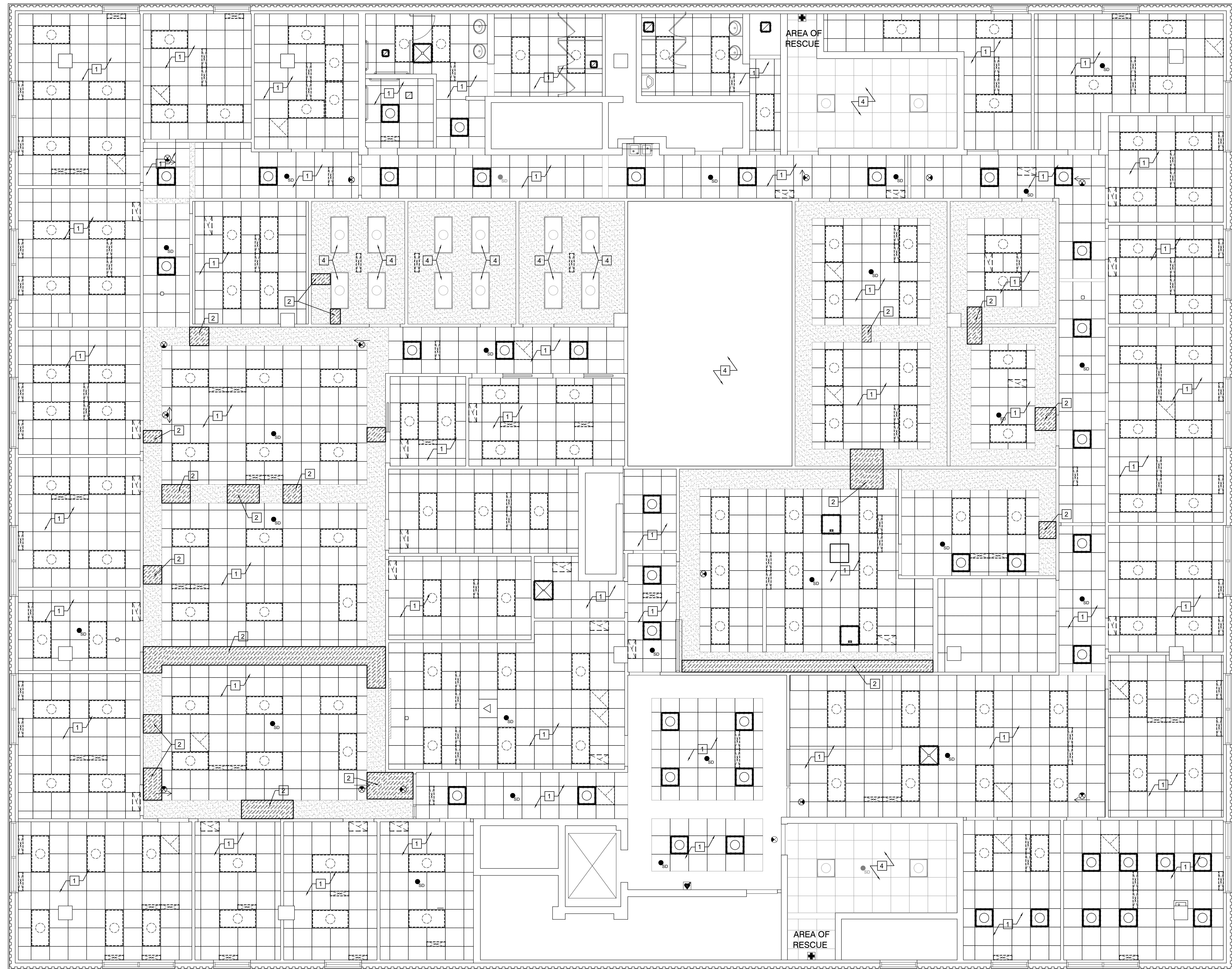
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8. REFER TO RENOVATIONS SHEETS FOR NEW WORK.

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- 4 EXISTING TO REMAIN.
- 5 NEW WALL PENETRATION & LINTEL FOR DUCT PENETRATION, SEE MECHANICAL DRAWINGS.



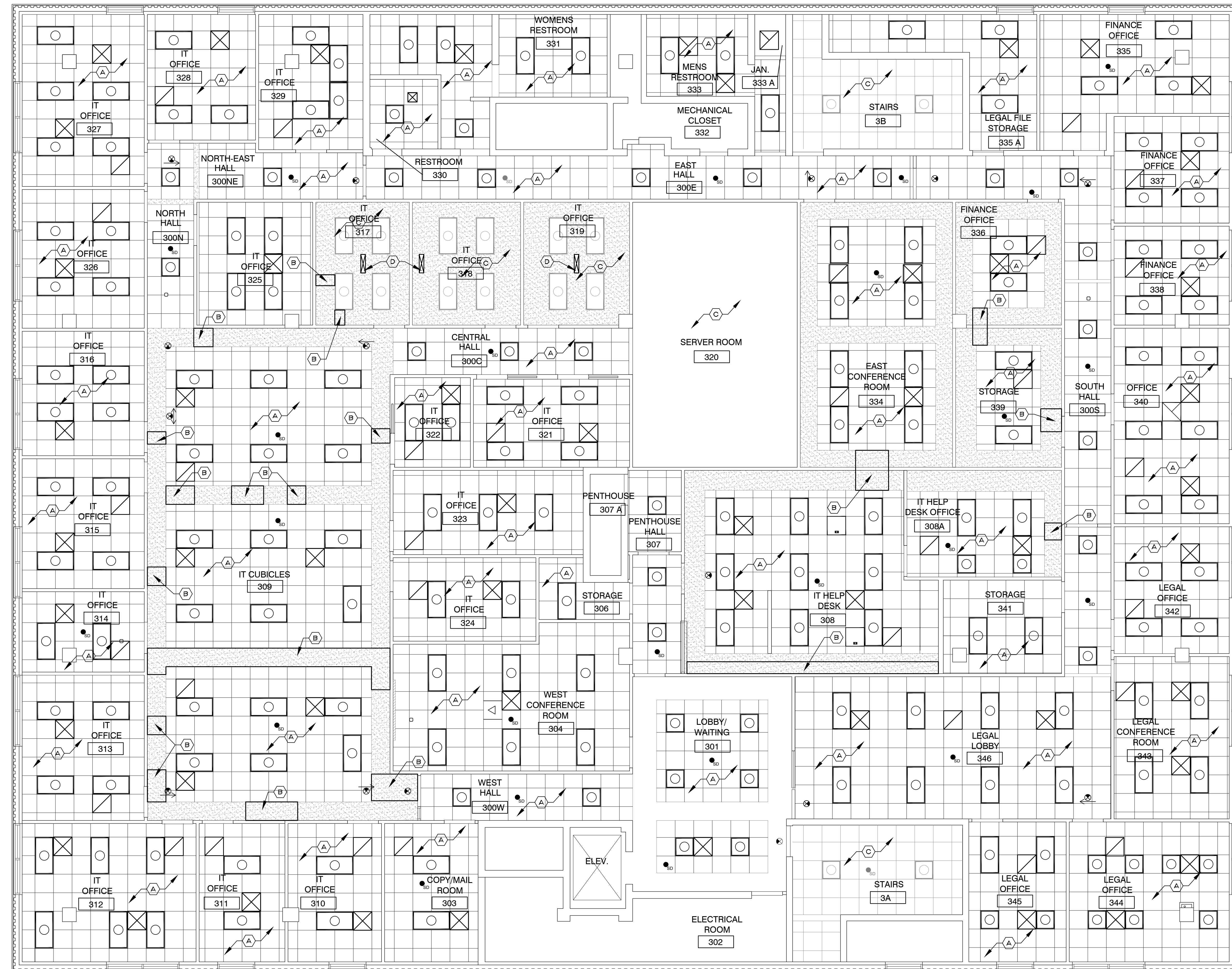
Demolition Reflected Ceiling Plan - Level 3 Phase I ①
3/16"=1'-0"

GENERAL NOTES

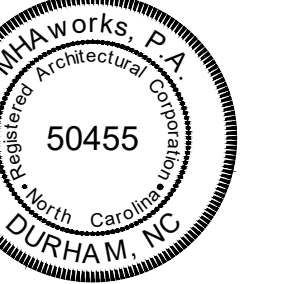
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NEW HVAC GRILLES TO BE INSTALLED.
- (B) PATCH & REPAIR SOFFITS AS NEEDED.
- (C) EXISTING CEILING.
- (D) NEW HVAC GRILLE.



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DATE: 3/21/2025

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CONSULTANT



PROJECT NAME

GUC Admin Building
HVAC Upgrades
Greenville, North Carolina

KEY PLAN

PROJECT NO.: 24125

DESIGNED BY: RLW

CHECKED BY:

DATE: 3/21/2025

SCALE:

SHEET NAME

Renovation Reflected Ceiling Plan & Notes

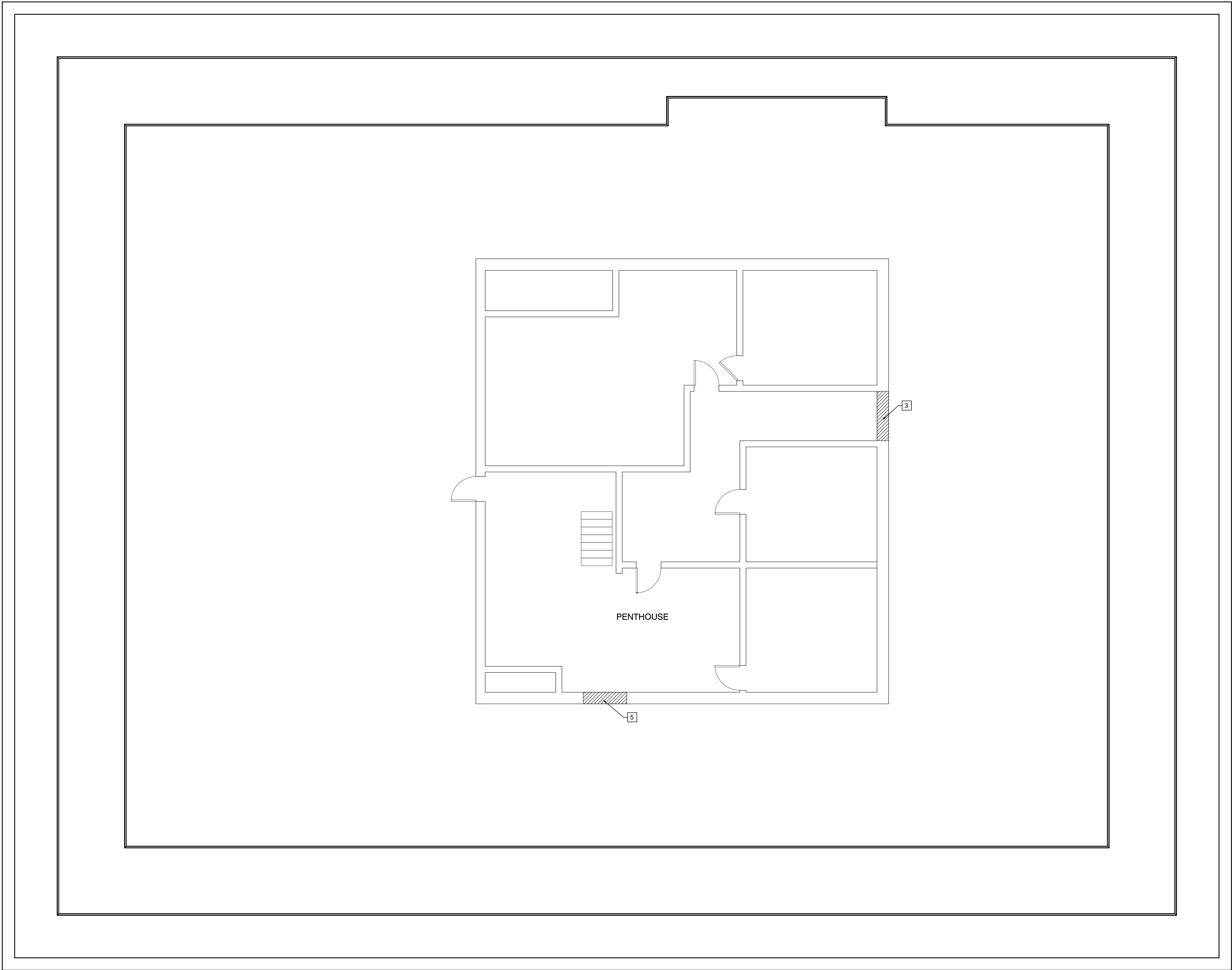
SHEET NUMBER

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Demolition/Renovation Floor Plan - Level 4 - Phase I 1
3/16"=1'-0"

N|V|5

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CONSULTANT



PROJECT NAME

GUC Admin Building
HVAC Upgrades
Greenville, North Carolina

KEY PLAN

PROJECT NO.: 24125

DESIGNED BY: RLW

CHECKED BY:

DATE: 3/21/2025





























































SCALE:

SHEET NAME

Demolition/Renovation Floor Plan & Notes

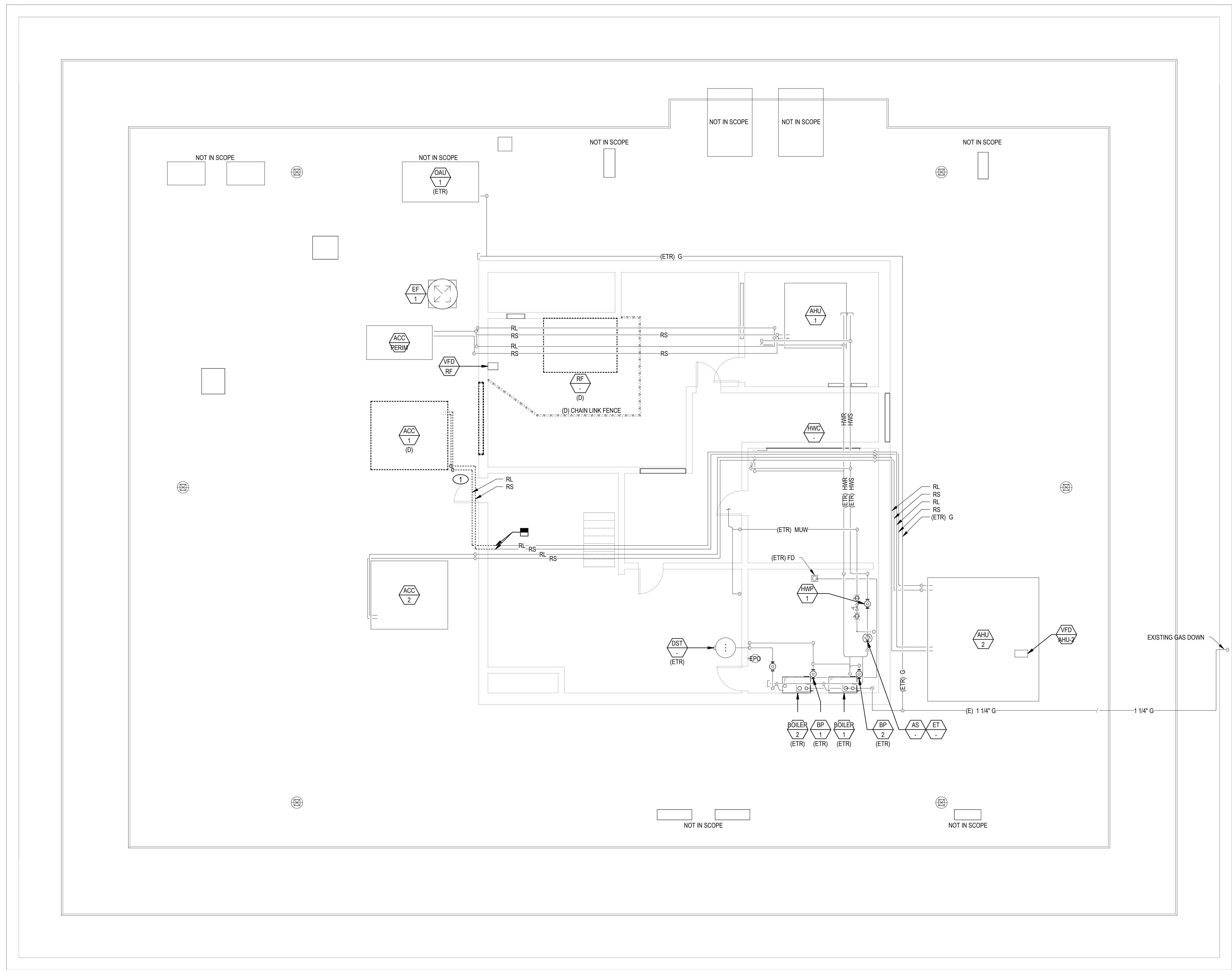
SHEET NUMBER

A1.5

GENERAL	
SYMBOL	DESCRIPTION
	KEY NOTE
	REVISION NUMBER
	POWERED MECHANICAL EQUIPMENT TYPE
	POWERED MECHANICAL EQUIPMENT NUMBER CFM/GPM, (TYP) INDICATES TYPICAL FOR SIMILAR EQUIPMENT
	NON-POWERED MECHANICAL EQUIPMENT TYPE
	NON-POWERED MECHANICAL EQUIPMENT NUMBER CFM/GPM, (TYP) INDICATES TYPICAL FOR SIMILAR EQUIPMENT
	AIR TERMINAL TYPE - ROUND NECK SIZE. SEE AIR TERMINAL SCHEDULE
250 (TYP)	CFM (TYP) INDICATES TYPICAL FOR SIMILAR DEVICES
	AIR TERMINAL TYPE - RECTANGULAR NECK SIZE. SEE AIR TERMINAL SCHEDULE
250 (TYP)	CFM (TYP) INDICATES TYPICAL FOR SIMILAR DEVICES
	LINEAR AIR TERMINAL TYPE - NECK SIZE - LENGTH. SEE AIR TERMINAL SCHEDULE
250 (TYP)	CFM (TYP) INDICATES TYPICAL FOR SIMILAR DEVICES
	CONNECTION TO EXISTING
	DISCONNECTION FROM EXISTING
	ELEVATION TAG
	SECTION DRAWING NUMBER
	REFERENCING SHEET
	CALLOUT DRAWING NUMBER
	REFERENCING SHEET
SINGLE LINE	
	EXISTING WORK TO REMAIN
	NEW WORK
	EXISTING WORK TO BE REMOVED (DEMO)
	BELOW FLOOR OR GRADE
CONTROLS	
SYMBOL	DESCRIPTION
	THERMOSTAT
	HUMIDISTAT
	SPACE TEMPERATURE SENSOR
	OCCUPANCY SENSOR
	CARBON DIOXIDE SENSOR
	CARBON MONOXIDE SENSOR
DUCTWORK	
SYMBOL	DESCRIPTION
	RECTANGULAR DUCTWORK (IN) / ROUND DUCTWORK (IN) / OVAL DUCTWORK (IN)
	SA' / OA' - SUPPLY / OUTSIDE AIR DUCT UP / DOWN
	RA' - RETURN AIR DUCT UP/DOWN
	EA' - EXHAUST AIR DUCT UP/DOWN
	RECTANGULAR SUPPLY, RETURN, EXHAUST - DIFFUSER, GRILLE, OR REGISTER
	ROUND SUPPLY, RETURN, EXHAUST - DIFFUSER, GRILLE, OR REGISTER
	DIFFUSER BLANKOFF
	LINEAR SLOT DIFFUSER, GRILLE OR REGISTER
	SIDEWALL SLOT DIFFUSER, GRILLE OR REGISTER
	SUPPLY AIR FLOW DIRECTION ARROW
	RETURN / EXHAUST AIR FLOW DIRECTION ARROW
	UNDERCUT DOOR (X = CFM OR DEPTH)
	RIGID DUCT / WITH ACOUSTICAL LINER. SIZE INDICATES INSIDE DIMENSIONS
	RIGID DUCT WITH INSULATION / WITH ACOUSTICAL LINER.
	FLEXIBLE DUCTWORK
	RADIUS DUCT ELBOW
	MITERED DUCT ELBOW
	DUCT TRANSITION
	RECTANGULAR TO ROUND TRANSITION
	RECTANGULAR / CONICAL TAKEOFF
	FIRE DAMPER W/ ACCESS DOOR
	SMOKE DAMPER W/ ACCESS DOOR
	COMBINATION FIRE/SMOKE DAMPER W/ ACCESS DOOR
	MOTORIZED DAMPER W/ ACCESS DOOR
	BACKDRAFT DAMPER
	MANUAL VOLUME DAMPER
	MANUAL VOLUME DAMPER WITH REMOTE OPERATION
	DUCT MOUNTED SMOKE DETECTOR W/ ACCESS DOOR
	AUTOMATIC DAMPER W/ ACCESS DOOR
	DUCT MOUNTED SMOKE DETECTOR
DRAWING GROUP ORGANIZATION	
	HVAC DISCIPLINE PREFIX
	GROUP DESIGNATION
	DRAWING NUMBER
	PHASE
M 0 0 1	GENERAL NOTES, SYMBOLS, ABBREVIATIONS, & SITE PLANS
MD 0 0 1	FLOOR PLANS, DEMOLITION
M 0 1 0	FLOOR PLANS, DUCTWORK
M 0 2 0	FLOOR PLANS, PIPING
M 0 3 0	LARGE SCALE PLANS & SECTIONS
M 0 4 0	RISER DIAGRAMS / FLOW DIAGRAMS
M 0 5 0	DETAILS & MISCELLANEOUS
M 0 6 0	SCHEDULES
M 7 0 1	CONTROL DIAGRAMS

MECHANICAL SHEET INDEX		
ISSUE	2024-03-31 CONSTRUCTION DOCUMENTS	
	2024-03-31 EQUIPMENT PRE-PURCHASE	
	SHEET NUMBER	SHEET DESCRIPTION
•	M001	MECHANICAL LEGEND, NOTES AND ABBREVIATIONS
•	M010-1	MECHANICAL DUCTWORK DEMO PLAN - LEVEL 3 - PHASE I
•	M0102-1	MECHANICAL DUCTWORK DEMO PLAN - ROOF - PHASE I
•	M0201-1	MECHANICAL PIPING DEMO PLAN - LEVEL 3 - PHASE I
•	M101-1	MECHANICAL DUCTWORK PLAN - LEVEL 3 - PHASE I
•	M102-1	MECHANICAL DUCTWORK PLAN - ROOF - PHASE I
•	M201-1	MECHANICAL PIPING PLAN - LEVEL 3 - PHASE I
•	M202-1	MECHANICAL PIPING PLAN - ROOF - PHASE I
•	M101-2	MECHANICAL DUCTWORK DEMO PLAN - LEVEL 2 - PHASE II
•	M102-2	MECHANICAL DUCTWORK DEMO PLAN - ROOF - PHASE II
•	M202-2	MECHANICAL PIPING DEMO PLAN - ROOF - PHASE II
•	M103-2	MECHANICAL DUCTWORK PLAN - LEVEL 2 - PHASE II
•	M102-2	MECHANICAL DUCTWORK PLAN - ROOF - PHASE II
•	M102-2	MECHANICAL DUCTWORK PLAN - ROOF - PHASE II
•	M103-2	MECHANICAL STRUCTURAL COORDINATION PLAN - ROOF - PHASE II
•	M201-2	MECHANICAL PIPING PLAN - LEVEL 2 - PHASE II
•	M202-2	MECHANICAL PIPING PLAN - ROOF - PHASE II
•	M401	MECHANICAL RISERS AND FLOW DIAGRAMS
•	M601	MECHANICAL DETAILS
•	M502	MECHANICAL DETAILS
•	M503	MECHANICAL DETAILS
•	M601	MECHANICAL CONTROLS
•	M602	MECHANICAL CONTROLS
•	M701	MECHANICAL SCHEDULES

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MECHANICAL PIPING DEMO PLAN -
ROOF - PHASE I

SHEET NOTES - HVAC DEMO:

(NOT ALL NOTES APPLY TO THIS DRAWING)

- A. ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. RETURN TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- B. CONTRACTOR TO COORDINATE WITH STRUCTURAL CONTRACTOR ON FINAL FRAMING DIMENSIONS PRIOR TO THE ORDER AND INSTALL OF AHU.
- C. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
- D. THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND ANY CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BID. VERIFY EXACT DETAIL OF INSTALLATION REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
- E. NO CUTTING OF THE BUILDING FLOOR, WALLS OR STRUCTURAL MEMBERS WHICH WILL DEGRADATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
- F. ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF "10'-0" FROM ALL EXHAUST OUTLETS, VTR'S (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
- G. THE CONTRACTOR SHALL CONFIRM THE SIZE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.

H.

PHASING SHEET NOTES - HVAC:



- A. EXISTING SYSTEMS SHALL REMAIN OPERABLE THROUGHOUT PHASE I EXCEPT WHERE NOTED OTHERWISE.
- B.

KEY NOTES ○

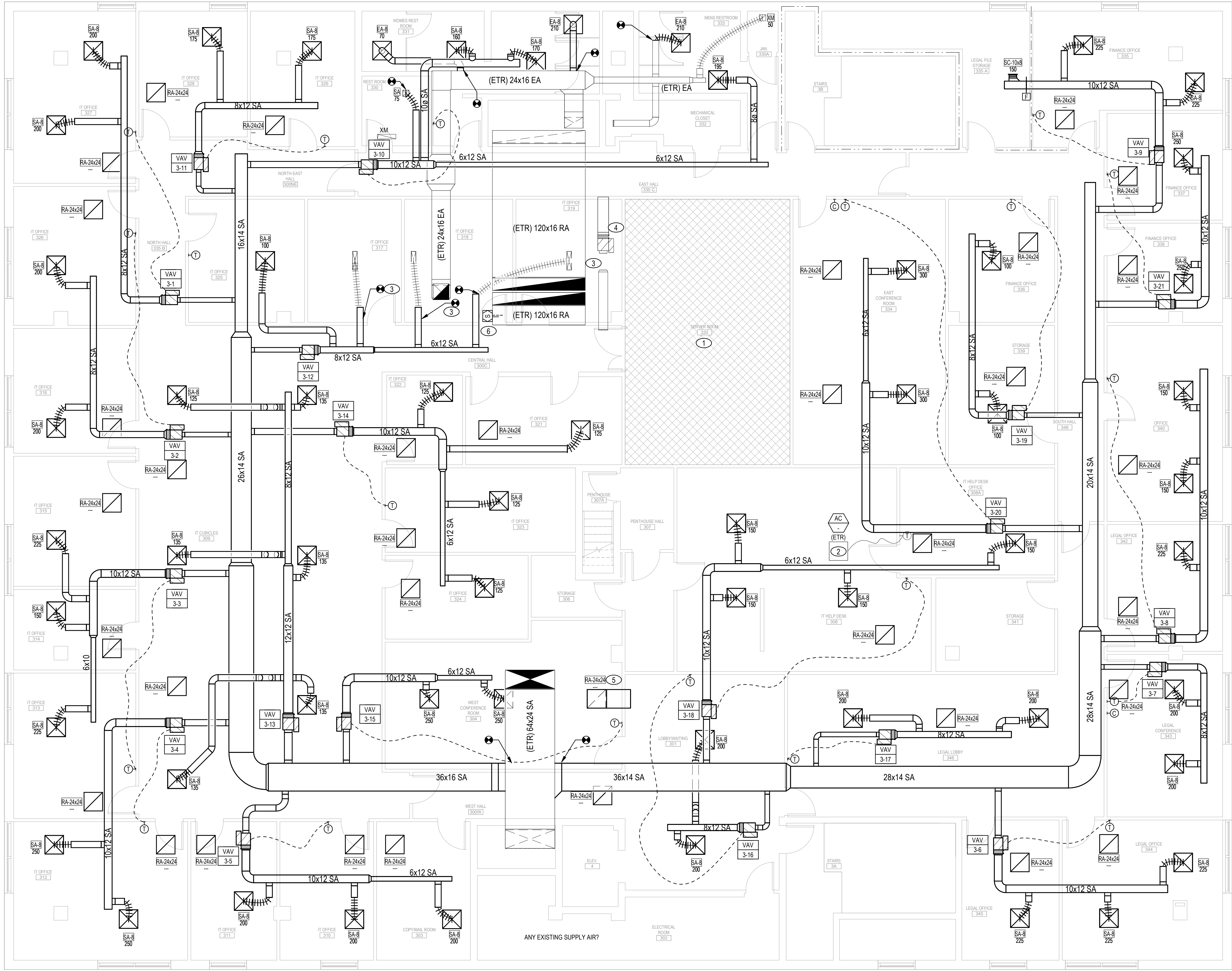
1. PHASE 1 - DEMOLISH EXISTING CONDENSING UNIT AND ASSOCIATED DX PIPING. PIPING SHALL BE CAREFULLY TRACED BACK TO ASSOCIATED COIL INSIDE EXISTING AHU-2 AND CAPPED OUTSIDE OF UNIT. REFRIGERANT SHALL BE RECLAIMED.

CONSTRUCTION LEGEND

- NON-RATED CONSTRUCTION
- 1-HR FIRE BARRIER
- 2-HR FIRE BARRIER

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CLIENT		
CONSULTANT		
PROJECT NAME		
GUC ADMIN BUILDING HVAC UPGRADE		
KEY PLAN		
		
REVISION/ISSUANCE		
#	DESCRIPTION	DATE
	CONSTRUCTION DOCUMENTS	03/21/25
PROJECT NO.: _____ 24-0006120		
DESIGNED BY: _____ IW		
CHECKED BY: _____ JJC		
DATE: _____ 03/21/2025		
SCALE: _____ As indicated		
SHEET NAME		
MECHANICAL PIPING DEMO PLAN - LEVEL 3 - PHASE I		
SHEET NUMBER		
MD201-1		

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1 MECHANICAL DUCTWORK PLAN - LEVEL 3 - PHASE I
M101-1 3/16" = 1'-0"

SHEET NOTES - HVAC:

(NOT ALL NOTES APPLY TO THIS DRAWING)

- ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
- THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND/OR CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BID. VERIFY EXACT DETAIL OF INSTALLATION REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
- NO CUTTING OF THE BUILDING FLOOR, WALLS OR STRUCTURAL MEMBERS WHICH WILL DEGRADE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
- ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF 10'-0" FROM ALL EXHAUST OUTLETS, VTR'S (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
- THE CONTRACTOR SHALL CONFIRM THE SIZE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.
- ALL PIPING TO VAV BOXES SHALL BE MINIMUM 3/4".

PHASING SHEET NOTES - HVAC:

- NEW VAV BOXES AND ASSOCIATED DUCTWORK SHALL BE INSTALLED ABOVE CEILING. EXACT LOCATIONS TO BE VERIFIED PRIOR TO FABRICATION TO MINIMIZE AREAS OF DEMOLITION AND CEILING REPLACEMENT.
- CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE EXISTING TO REMAIN SYSTEMS, PIPING, WIRING, CONDUIT, ETC. NOT ASSOCIATED WITH SCOPE OF WORK.

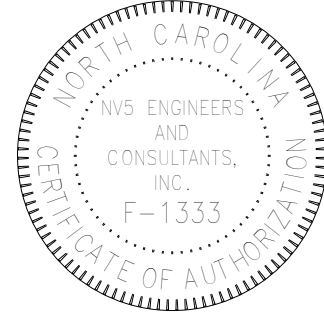
KEY NOTES

- HVAC SYSTEM ASSOCIATED WITH SERVER ROOM NOT PART OF SCOPE. CONTRACTOR SHALL ENSURE THAT ALL ASSOCIATED SYSTEMS AND CONTROLS REMAIN ONLINE AND UNINTERRUPTED THROUGHOUT CONSTRUCTION.
- EXISTING LG CEILING CASSETTE UNIT SHALL REMAIN. CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE DURING CONSTRUCTION.
- EXISTING OFFICES HAVE HARD CEILINGS. EXISTING SUPPLY DIFFUSERS AND ASSOCIATED DUCTWORK SHALL REMAIN. CONNECT TO EXISTING FLEX WHERE POSSIBLE TO AVOID HARD CEILING DEMOLITION. RE-BALANCE EXISTING GRILLES TO 100 CFM EACH (TYP. FOR THREE HARD CEILING OFFICES).
- ABANDON EXISTING TERMINAL UNIT AND ASSOCIATED DUCTWORK ABOVE HARD CEILING.
- EXTEND SOUND BOOT THROUGHT WALL AND TERMINATE WITH WIRE MESH END.
- PROVIDE ACCESS FOR DUCT MOUNTED SMOKE DETECTOR.

CONSTRUCTION LEGEND

- NON-RATED CONSTRUCTION
- 1-HR FIRE BARRIER
- 2-HR FIRE BARRIER

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CLIENT

CONSULTANT

PROJECT NAME

KEY PLAN

REVISION/ISSUANCE

DESCRIPTION DATE

CONSTRUCTION DOCUMENTS 03/21/25

PROJECT NO.:

DESIGNED BY:

CHECKED BY:

DATE:

SCALE:

As indicated

SHEET NAME

MECHANICAL

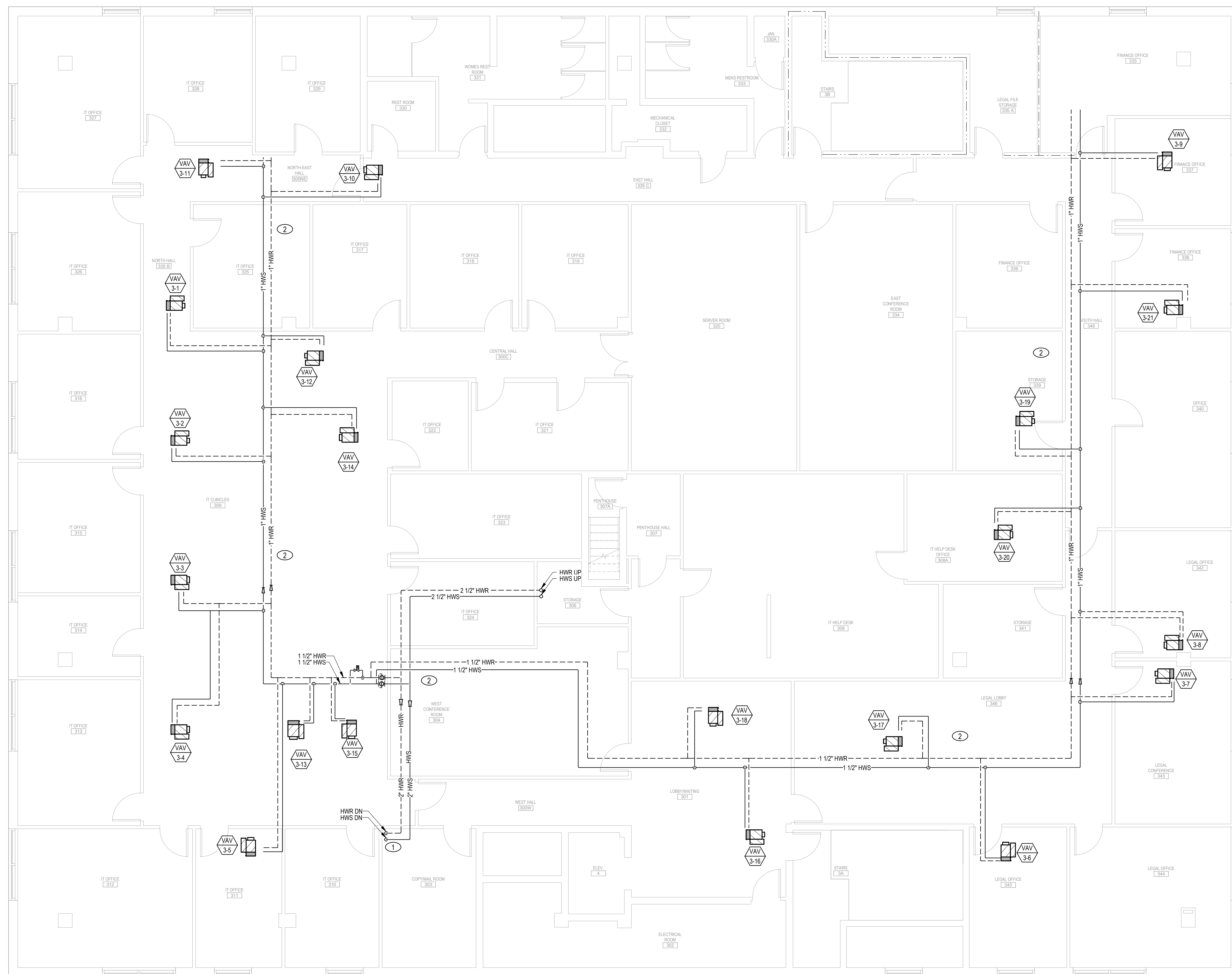
DUCTWORK

PLAN - LEVEL 3 -

PHASE I

SHEET NUMBER

M101-1



1 MECHANICAL PIPING PLAN - LEVEL 3 - PHASE I
M201-1 3/16" = 1'-0"

$$\frac{3}{16}'' = 1'-0''$$

SHEET NOTES - HVAC:




(NOT ALL NOTES APPLY TO THIS DRAWING)

- A. ALL RETURN GRILLES SHALL HAVE SOUND ROOTS ABOVE CEILING REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- B. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
- C. THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND/OR CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BID. EXACT DETAIL IDENTIFICATION IS REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
- D. NO CUTTING OF THE BUILDING FLOOR, WALLS OR STRUCTURAL MEMBERS WHICH WILL DEGRADE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
- E. ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF 10'-0" FROM ALL EXHAUST OUTLETS, VYRS (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
- F. THE CONTRACTOR SHALL CONFIRM THE SIZE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.
- G. ALL PIPING TO VAV BOXES SHALL BE MINIMUM 3/4".

KEY NOTES

1. CONTRACTOR SHALL INSTALL AN ENCLOSURE AROUND PIPING DOWN TO SECOND FLOOR.
2. COORDINATE EXACT LOCATION AND ROUTING OF NEW PIPING TO MINIMIZE DISRUPTION OF EXISTING TO REMAIN CEILINGS.

CONSTRUCTION LEGEND

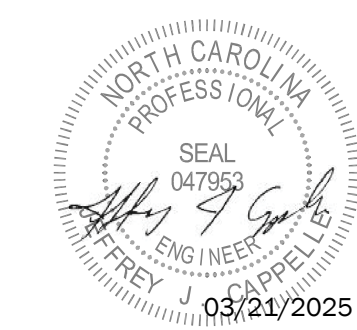
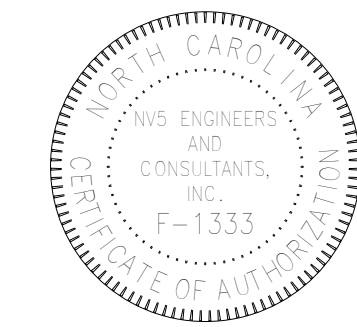
-  NON-RATED CONSTRUCTION
-  1-HR FIRE BARRIER
-  2-HR FIRE BARRIER

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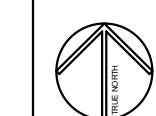
CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

[illegible]

PROJECT NO.: 24-000612

DESIGNED BY: _____ IV

CHECKED BY: _____

CHECKED BY: _____ 03/24/2003

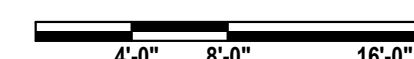
DATE: 03/21/2022

SHEET NAME

MECHANICAL
PIPING PLAN -
LEVEL 3 -
PHASE I

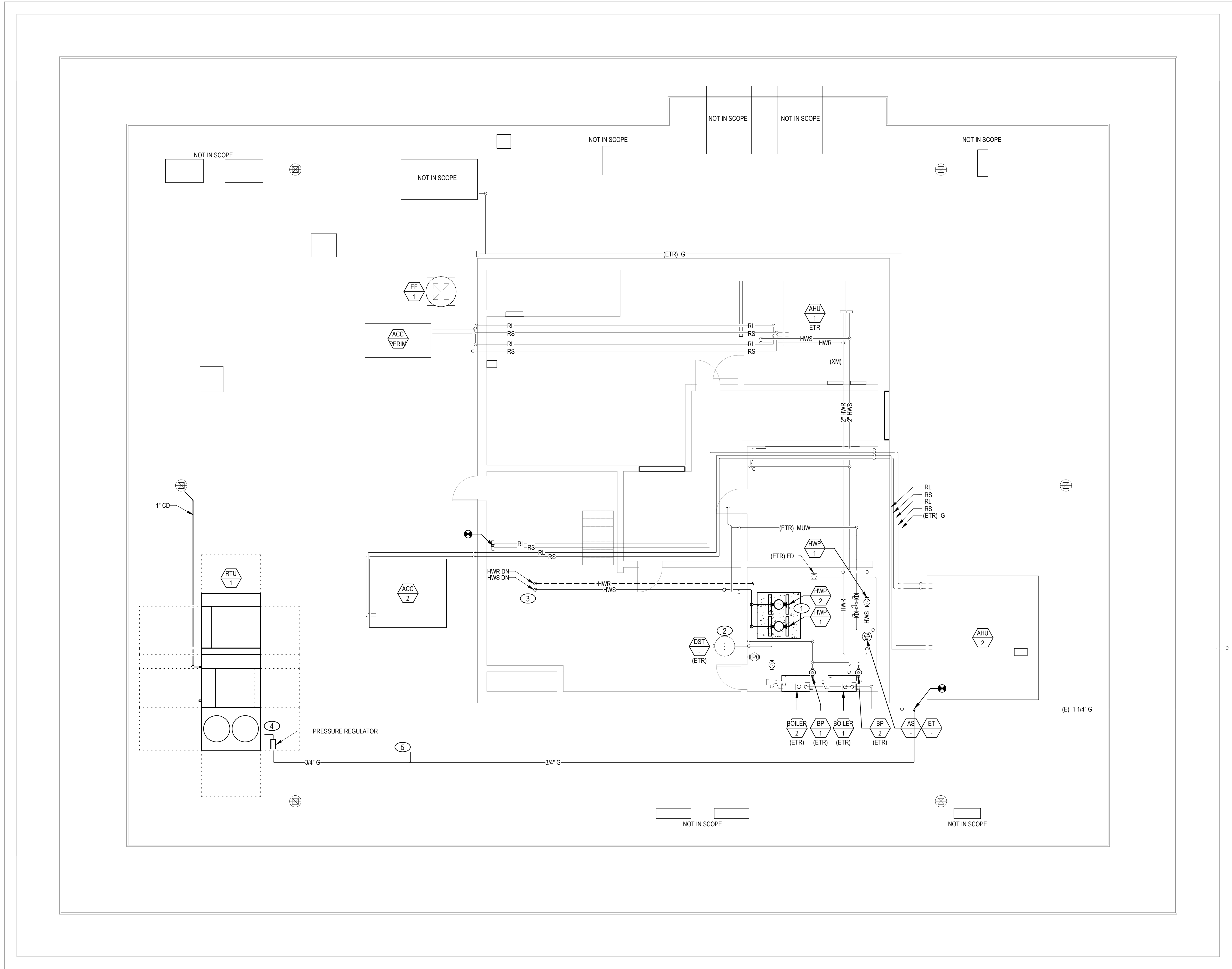
SHEET NUMBER

M201-1



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1 MECHANICAL PIPING PLAN - ROOF - PHASE I
M202-1 3/16" = 1'-0"



SHEET NOTES - HVAC:

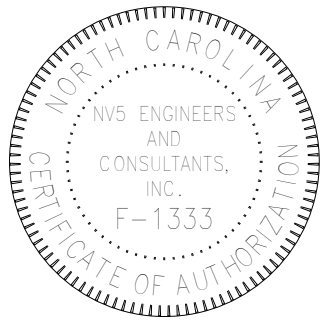
- (NOT ALL NOTES APPLY TO THIS DRAWING)
- ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
 - CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
 - THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND/OR CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BID. VERIFY EXACT DETAIL OF INSTALLATION REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
 - NO CUTTING OF THE BUILDING FLOOR, WALLS OR STRUCTURAL MEMBERS WHICH WILL DEGRADE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
 - ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF 10'-0" FROM ALL EXHAUST OUTLETS, VTRS (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
 - THE CONTRACTOR SHALL CONFIRM THE SIZE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.
 - ALL PIPING TO VAV BOXES SHALL BE MINIMUM 3/4".

KEY NOTES

- NEW INLINE PUMPS SHALL BE INSTALLED ALONG WITH ASSOCIATED PIPING DOWN TO THIRD FLOOR. EXISTING BOILERS TO REMAIN ONLINE THROUGHOUT PHASE 1. CONTRACTOR TO COORDINATE SHUTDOWN TO MODIFY PIPING FROM EXISTING BOILERS TO NEW PUMPS.
- EXISTING PLUMBING SYSTEM (STORAGE TANK, PUMPS, PIPING AND ASSOCIATED VALVES) SHALL REMAIN. CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE DURING CONSTRUCTION.
- NEW HWS/R PIPING DOWN TO FLOOR BELOW.
- PROVIDE NATURAL GAS REGULATOR AT EACH PIECE OF EQUIPMENT. GAS REGULATOR SHALL BE MAXITROL MODEL NUMBER 325-5L48 (3/4"x3/4", 1/4"WC) WITH OP48 AND VENT PROTECTOR 13A15-5. INSTALL PER MANUFACTURER REQUIREMENTS.
- INSTALL BRANCH OF NATURAL GAS PIPING THAT WILL FEED AHU-2. CAP FOR FUTURE CONNECTION IN PHASE 2.

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PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120
DESIGNED BY: IW
CHECKED BY: JUC
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

SHEET NAME

MECHANICAL
PIPING PLAN -
ROOF - PHASE I

SHEET NUMBER

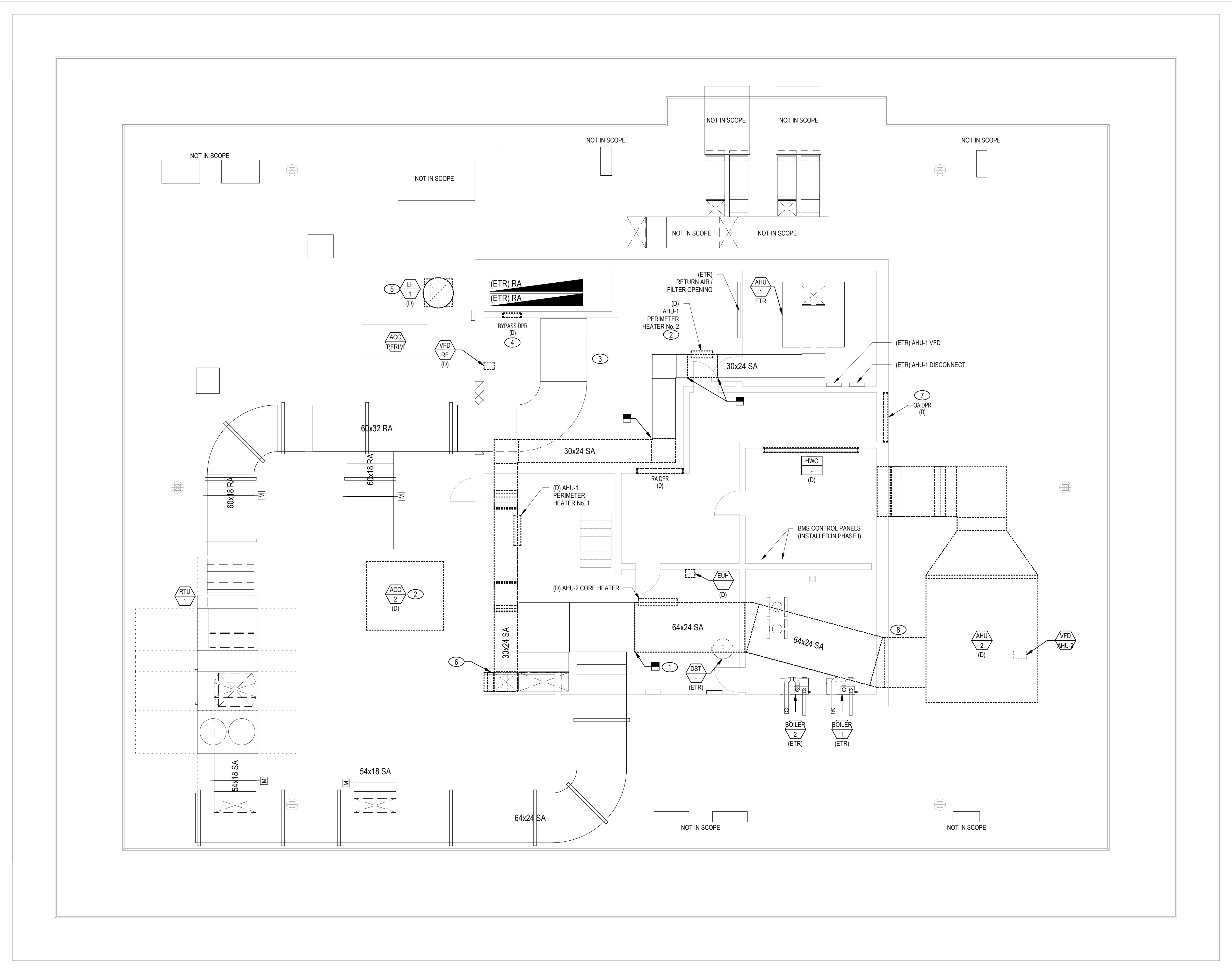
M202-1

4'-0" 8'-0" 16'-0"

Architect: Davis Brody Bond, 2024-08-08 10:30 AM, 3300 Regency Parkway, Suite 100, Cary, NC 27513, USA
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MECHANICAL DUCTWORK DEMO PLAN -
ROOF - PHASE II

1
MD102-2 3/16" = 1'-0"



SHEET NOTES - HVAC DEMO:

(NOT ALL NOTES APPLY TO THIS DRAWING)

- ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- CONTRACTOR TO COORDINATE WITH STRUCTURAL CONTRACTOR ON FINAL FRAMING DIMENSIONS PRIOR TO THE ORDER AND INSTALL OF AHU.
- CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
- THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND/OR CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BID. VERIFY EXACT DETAIL OF INSTALLATION REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
- NO CUTTING OF THE BUILDING FLOOR, WALLS OR STRUCTURAL MEMBERS WHICH WILL DEGRADATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
- ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF 10'-0" FROM ALL EXHAUST OUTLETS, VTRS (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
- THE CONTRACTOR SHALL CONFIRM THE SIZE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.
-

PHASING SHEET NOTES - HVAC:

- EXISTING PENTHOUSE DUCTWORK DEMOLITION ASSOCIATED WITH LEVEL 3 SHALL BE CONDUCTED AT THE END OF PHASE 1 PRIOR TO PHASE 2 BEGINNING. COORDINATE ALL SHUTDOWNS WITH OWNER AS REQUIRED.
-

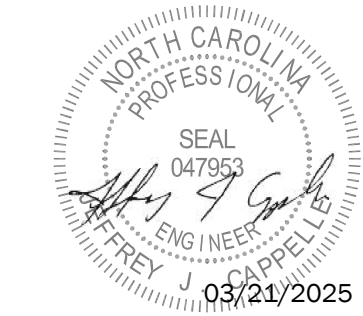
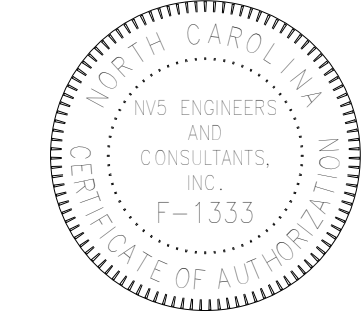
KEY NOTES

- SUPPLY DUCTWORK AND ASSOCIATED HANGERS AND SUPPORTS SHALL BE CONNECTED. REFER TO KEYNOTE #6 ON RENOVATION DRAWINGS M102-2. CONTRACTOR SHALL MINIMIZE DISRUPTION TO SUPPLY AIR SERVICE.
- DEMO EXISTING AHU-1 PERIMETER HEATER No. 2 AND PATCH DUCTWORK.
- EXISTING RETURN FAN AND ASSOCIATED VFD SHALL BE REMOVED. EXISTING ROUND OPENING IN PLENUM SHALL BE PATCHED AND PREPARED FOR NEW RECTANGULAR CONNECTION. EXISTING RETURN FAN SHALL REMAIN OPERATIONAL UNTIL THE END OF PHASE 1. CONTRACTOR SHALL COORDINATE SHUTDOWN BETWEEN PHASES.
- EXISTING BYPASS LOUVER SHALL BE DEMOLISHED. EXISTING BYPASS OPENING SHALL BE PATCHED.
- EXISTING EXHAUST FAN SHALL BE REMOVED. EXISTING CURB SHALL BE EXAMINED FOR REUSE FOR NEW FAN.
- CAP EXISTING PERIMETER DUCTWORK ABOVE FLOOR.
- COVER AND SEAL EXISTING LOUVER OPENING WITH INSULATED GALVANIZED SHEET METAL.
- PROVIDE INSULATED SHEET METAL PANEL OVER DUCT OPENING.

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GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE		
#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

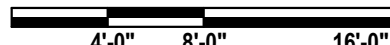
PROJECT NO.: 24-0006120
DESIGNED BY: IW
CHECKED BY: JUC
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

SHEET NAME

MECHANICAL
DUCTWORK
DEMO PLAN -
ROOF - PHASE II

SHEET NUMBER

MD102-2





- A. ALL RETURN GRILLS SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- B. CONTRACTOR TO COORDINATE WITH STRUCTURAL CONTRACTOR ON FINAL FRAMING DIMENSIONS PRIOR TO THE ORDER AND INSTALL OF AHU.
- C. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
- D. THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND/OR CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BEGINNING EXACT DUCTWORK INSTALLATION REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
- E. NO CUTTING OF THE BUILDING FLOOR WALLS OR STRUCTURAL MEMBERS WHICH WILL DEGRADATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
- F. ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF 10'-0" FROM ALL EXHAUST OUTLETS, VENTS (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
- G. THE CONTRACTOR SHALL CONFIRM THE SITE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.

A. BOILER ROOM PIPING SHALL BE DEMOLISHED AND REWORKED AT THE BEGINNING OF PHASE 2 TO MINIMIZE DOWN TIME OF THIRD FLOOR RE HEAT CAPABILITIES.

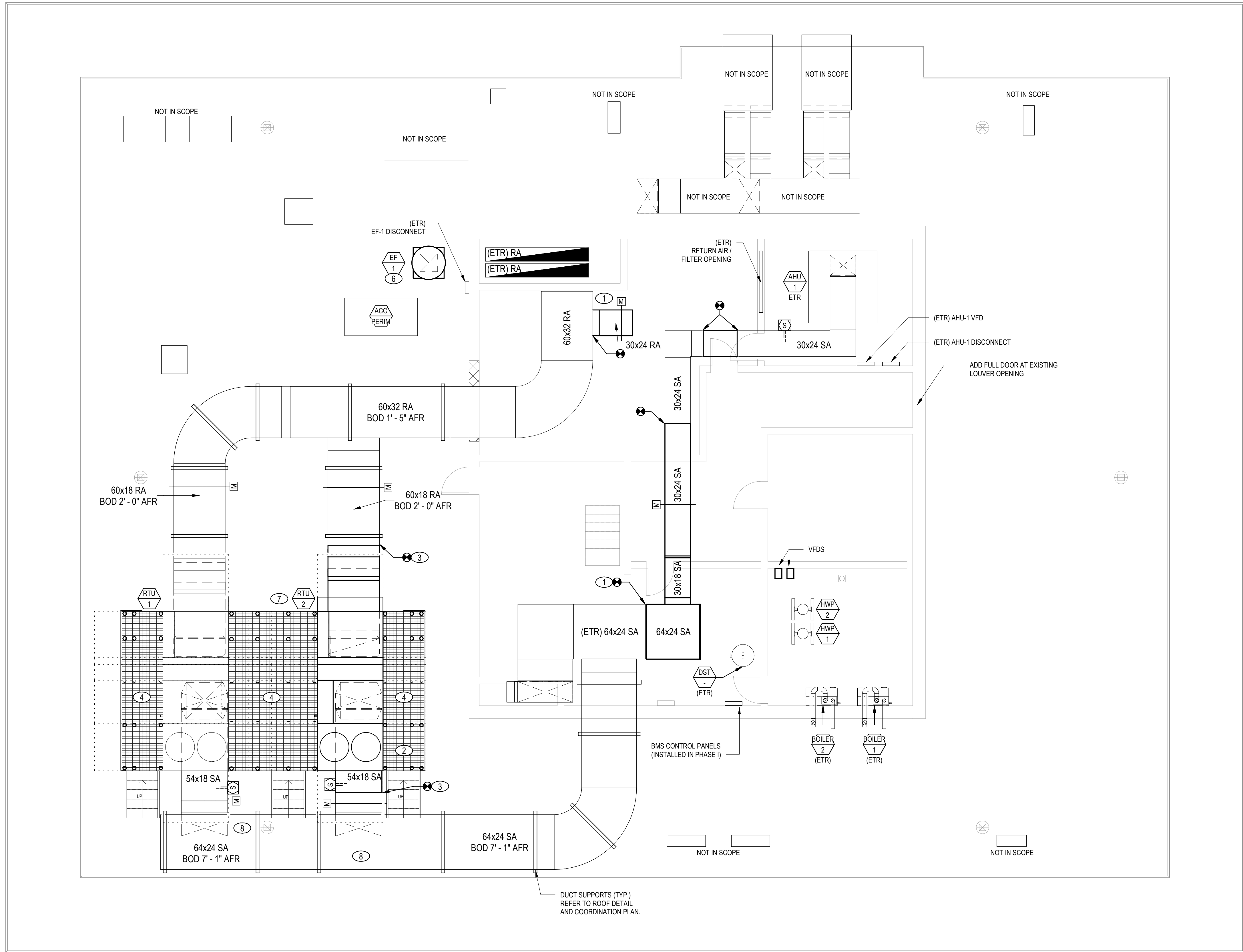
B.

1. DEMOLISH EXISTING CONDENSING UNIT AND ASSOCIATED DX PIPING. PIPING SHALL BE CAREFULLY TRACED BACK TO ASSOCIATED COIL INSIDE EXISTING AHU-2 AND CAPPED OUTSIDE OF UNIT. REFRIGERANT SHALL BE RECLAIMED.
2. EXISTING PRIMARY PUMP SHALL BE REMOVED.
3. EXISTING MAKEUP WATER PIPING ASSEMBLY TO REMAIN WHERE INDICATED. PIPING SHALL BE MODIFIED TO CONNECT TO NEW SYSTEM AS REQUIRED.
4. EXISTING PLUMBING SYSTEM (STORAGE TANK, PUMPS, PIPING AND ASSOCIATED VALVES) SHALL REMAIN. CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE DURING CONSTRUCTION.

Autodesk Docs://594_24-0006120 - GUC Admin Building HVAC Upgrade/HVAC Upgrade_MEP/23.rvt
3/21/2025 11:32:36 AM

Architect: Davis Brody Bond, 2024-08-08 10:30 AM, 3/16" = 1'-0", GUC Admin Building HVAC Upgrade, MEP/23-14, 3/16/2025 11:32:42 AM

1 MECHANICAL DUCTWORK PLAN - ROOF - PHASE II
M102-2 3/16" = 1'-0"



SHEET NOTES - HVAC:

(NOT ALL NOTES APPLY TO THIS DRAWING)

- ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
- THE MECHANICAL CONTRACTOR SHALL PERFORM A SITE OBSERVATION SURVEY TO DETERMINE LIMITATIONS AND/OR CONFLICTS RELATIVE TO THE EXECUTION OF WORK PRIOR TO BID. VERIFY EXACT DETAIL OF INSTALLATION REQUIRED TO PROVIDE SYSTEMS SHOWN WITHIN SPACE INTENDED.
- NO CUTTING OF THE BUILDING FLOOR, WALLS OR STRUCTURAL MEMBERS WHICH WILL DETERIORATE THE INTEGRITY AND STRENGTH OF THE BUILDING WILL BE ALLOWED WITHOUT WRITTEN APPROVAL FROM THE STRUCTURAL ENGINEER.
- ALL OUTSIDE AIR INTAKES MUST BE LOCATED A MINIMUM OF 10'-0" FROM ALL EXHAUST OUTLETS, VTRS (VENT THRU ROOF) AND HEAT REJECTING EQUIPMENT.
- THE CONTRACTOR SHALL CONFIRM THE SIZE OF CONNECTIONS TO EXISTING EQUIPMENT, DUCTWORK AND PIPING IN THE FIELD PRIOR TO FABRICATION.
- ALL PIPING TO VAV BOXES SHALL BE MINIMUM 3/4".

PHASING SHEET NOTES - HVAC:

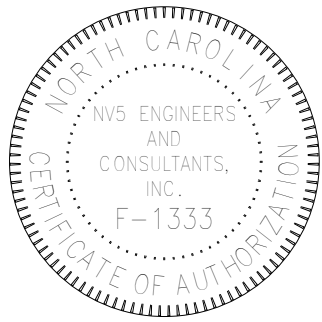
- ALL NEW DUCT CONNECTIONS NECESSARY FOR RTU-1 TO CONTROL LEVEL 3 SHALL BE FINALIZED PRIOR TO BEGINNING PHASE 2 SCOPE OF WORK. COORDINATE ALL SHUTDOWNS WITH OWNER AS REQUIRED.

KEY NOTES

- NEW DUCTWORK SHALL BE MODIFIED AT THE END OF PHASE 1 PRIOR TO PHASE 2 BEGINNING TO ALLOW RTU-1 TO TAKE OVER CONDITIONING OF THIRD FLOOR. COORDINATE SHUTDOWN WITH OWNER TO ALLOW TIME TO MODIFY AND CONNECT NEW DUCTWORK AS REQUIRED.
- RTU SHALL SIT ON RAISED PLENUM.
- CONNECT DUCTWORK INSTALLED IN PHASE 1 TO RTU-2.
- PROVIDE AND INSTALL SERVICE PLATFORM COMPLETE WITH SAFETY RAILINGS AND STAIRS. REFER TO SPECIFICATIONS FOR MORE INFORMATION.
- REFER TO ROOF MOUNTED DUCTWORK DETAIL FOR EXPOSED DUCT INSULATION REQUIREMENTS.
- INSTALL NEW EXHAUST FAN OVER EXISTING EXHAUST OPENING. NEW FAN SHALL BE PROVIDED WITH NEW MOTORIZED CONTROL DAMPER. COORDINATE MFG CURB DIMENSIONS WITH EXISTING OPENING. PRIOR TO ORDERING FAN, ASSOCIATED VFD SHALL BE ENCLOSED IN A NEMA RATED BOX SUITABLE FOR OUTDOOR INSTALLATION.
- REFER TO MECHANICAL COORDINATION PLAN ON SHEET M103-2 FOR AHU LOCATION AND FITMENT.
- CONTRACTOR SHALL INSTALL CONNECTING DUCTWORK AND SUPPORT POST AS REQUIRED TO ACCOMMODATE A MINIMUM 3'-0" CLEAR SPACE UNDERNEATH DUCTWORK TO MAINTAIN UNIT SERVICEABILITY.

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CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120

DESIGNED BY: IW

CHECKED BY: JUC

DATE: 03/21/2025

SCALE: 3/16" = 1'-0"

SHEET NAME

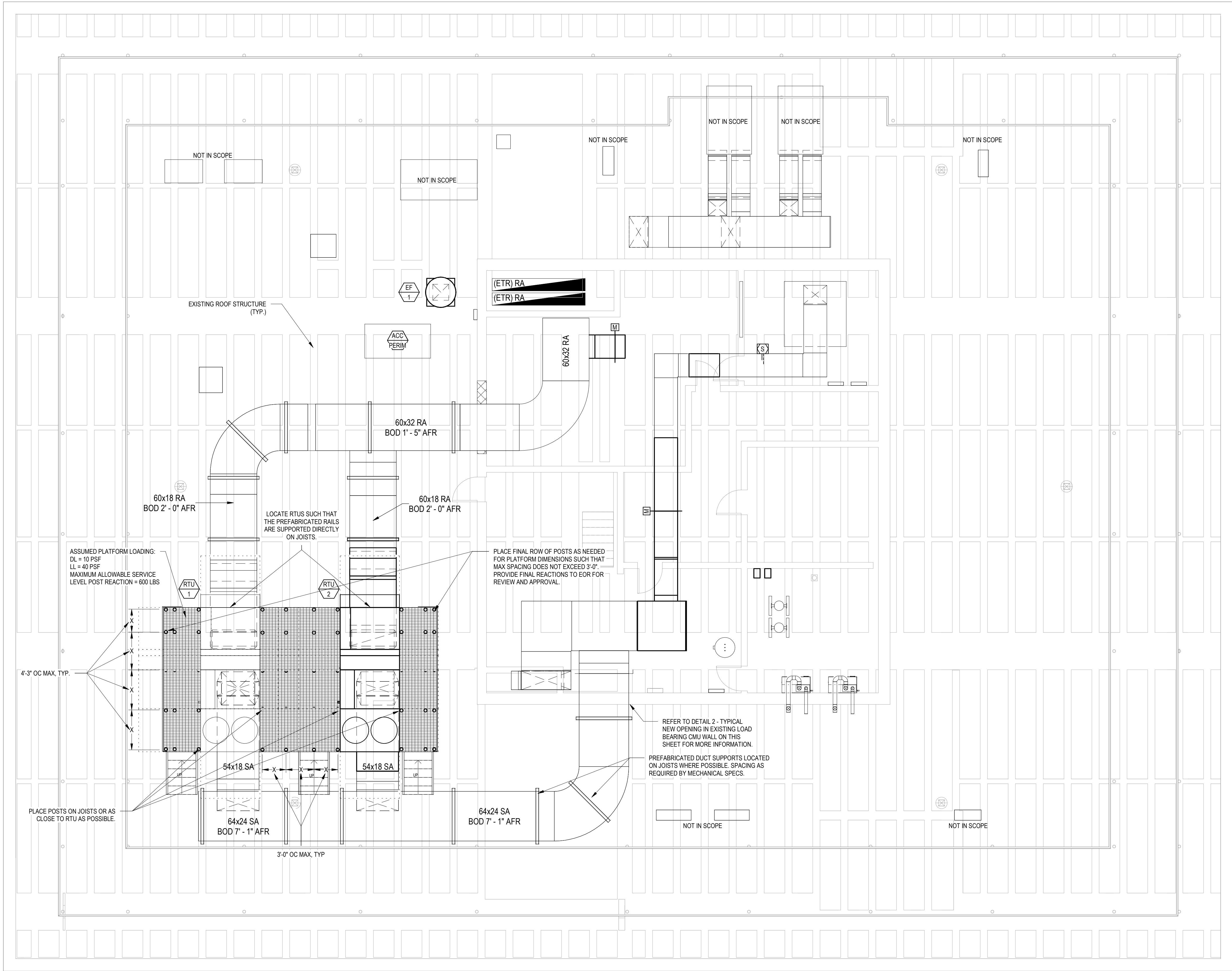
MECHANICAL
DUCTWORK
PLAN - ROOF -
PHASE II

SHEET NUMBER

M102-2

4'-0" 8'-0" 16'-0"

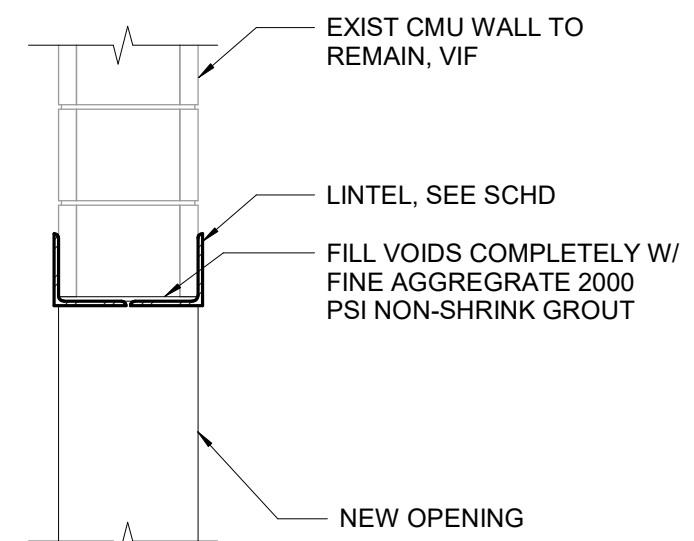
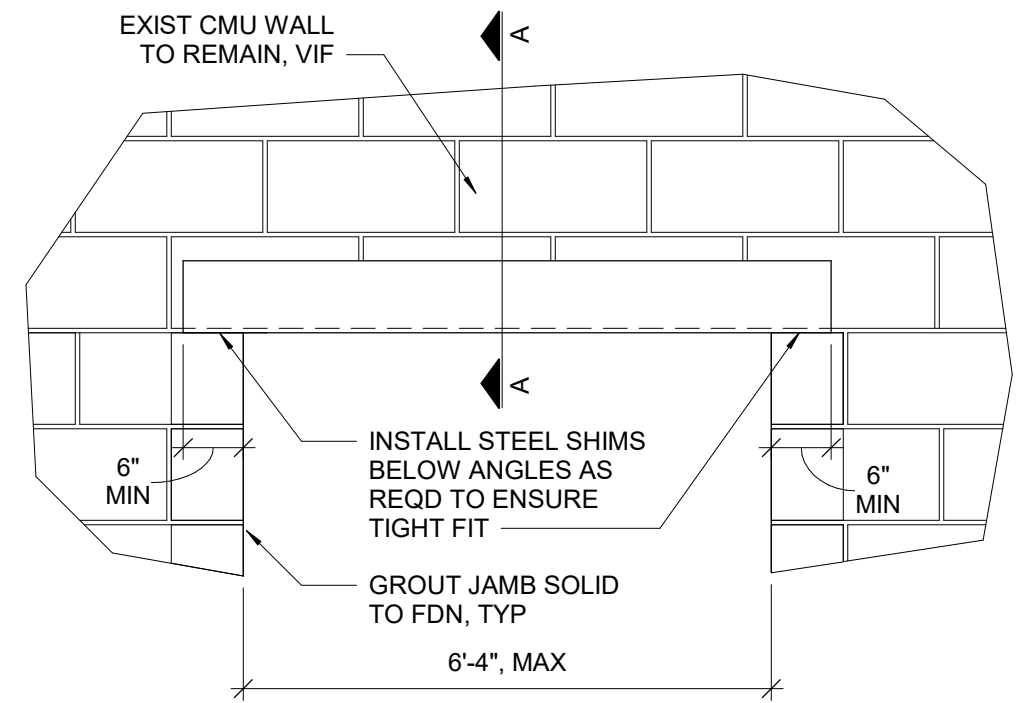
Architect: Davis Brody Bond, 2024-0006-020 - GUC Admin Building HVAC Upgrade - MEP/23-1
3/2/2025 11:32:43 AM



MECHANICAL STRUCTURAL COORDINATION PLAN - ROOF - PHASE II

1
M103-2 3/16" = 1'-0"

LINTEL SCHEDULE FOR NEW OPENING IN EXISTING LOAD BEARING CMU WALL		
EXIST WALL THICKNESS	MASONRY OPENING	
	UP TO 6'-4"	6" BEARING EACH END
8"	(2) L6X4X3/8, LLV	L J
12"	(2) L6X6X3/8	L J



SECTION A-A

- NOTES:**
- CONTRACTOR SHALL SHORE EXISTING WALL UNTIL ANGLES ARE INSTALLED & GROUT HAS SET AT LEAST 3 DAYS.
 - SEE PLANS FOR LOCATIONS.

2 TYPICAL NEW OPENING IN EXISTING LOAD BEARING CMU WALL

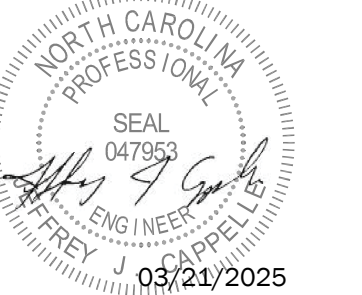
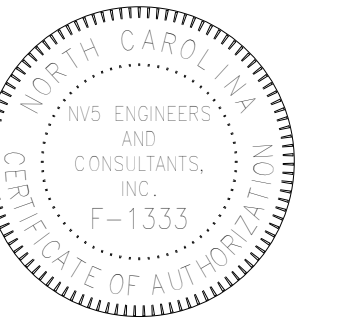
SCALE: NONE

4'-0" 8'-0" 16'-0"

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CONSULTANT

PROJECT NAME

GUC ADMIN BUILDING HVAC UPGRADE

KEY PLAN



REVISION/ISSUANCE		
#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120
DESIGNED BY: IW
CHECKED BY: JUC
DATE: 03/21/2025
SCALE: As indicated

SHEET NAME

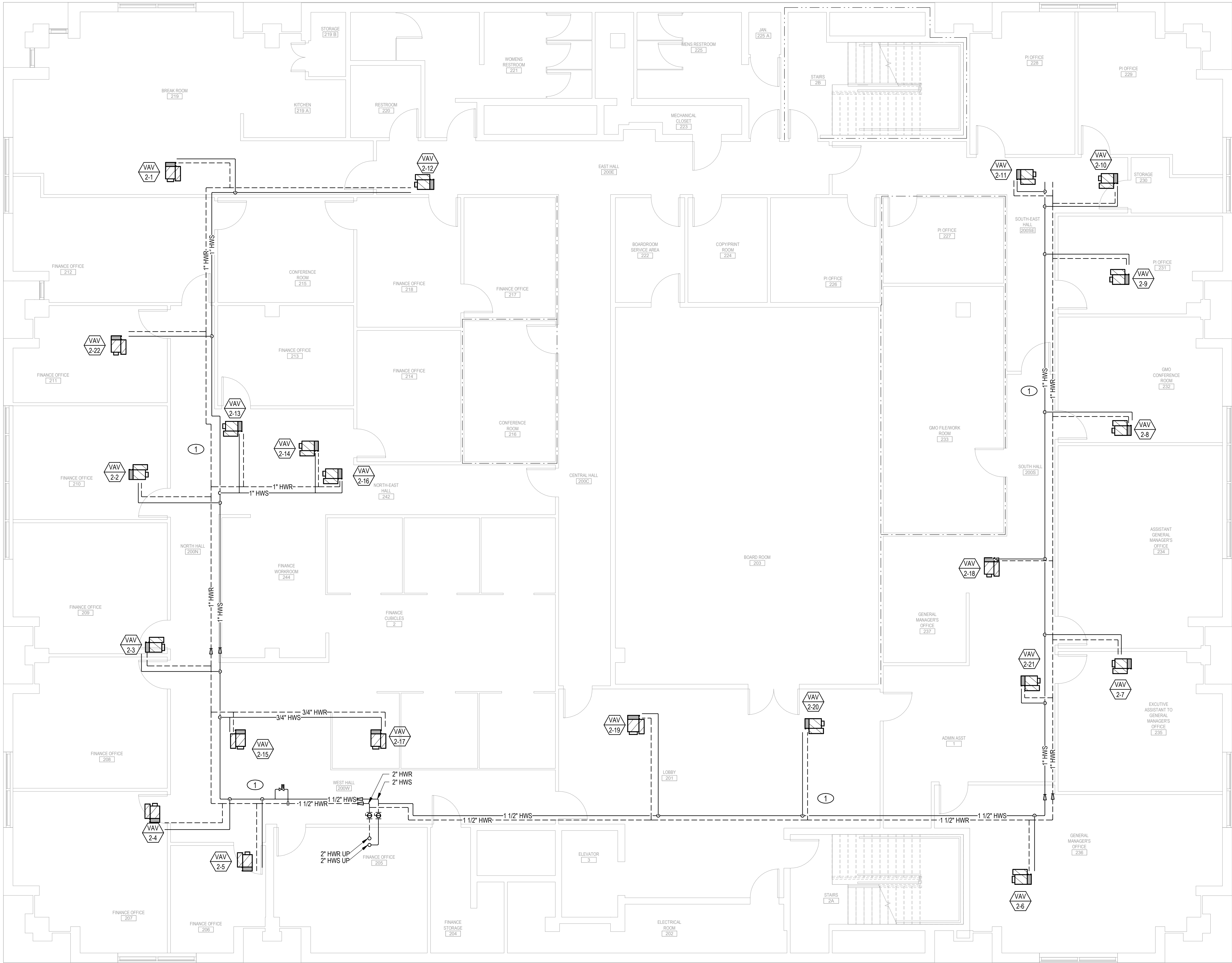
MECHANICAL STRUCTURAL COORDINATION PLAN - ROOF - PHASE II

SHEET NUMBER

M103-2

Autodesk DWGPlotter 2024-04-08 08:28 - GUC Admin Building HVAC Upgrade-0008120_GUC Admin Building HVAC Upgrade_MEP201-2.dwg
3/21/2025 11:32:46 AM

1 MECHANICAL PIPING PLAN - LEVEL 2 - PHASE II
M201-2 3/16" = 1'-0"



SHEET NOTES - HVAC:

(NOT ALL NOTES APPLY TO THIS DRAWING)

- ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
- CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO OR REPLACEMENT OF ALL EXISTING BUILDING SYSTEMS AND FINISHES DAMAGED DURING CONSTRUCTION.
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- ALL PIPING TO VAV BOXES SHALL BE MINIMUM 3/4".

KEY NOTES

- COORDINATE EXACT LOCATION AND ROUTING OF NEW PIPING TO MINIMIZE DISRUPTION OF EXISTING TO REMAIN CEILING.

CONSTRUCTION LEGEND

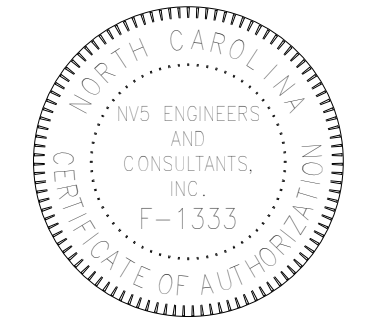
- NON-RATED CONSTRUCTION
- 1-HR FIRE BARRIER
- 2-HR FIRE BARRIER

4'-0" 8'-0" 16'-0"

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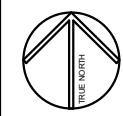
CLIENT

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BUILDING HVAC
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1	CONSTRUCTION DOCUMENTS	03/21/25

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SHEET NAME

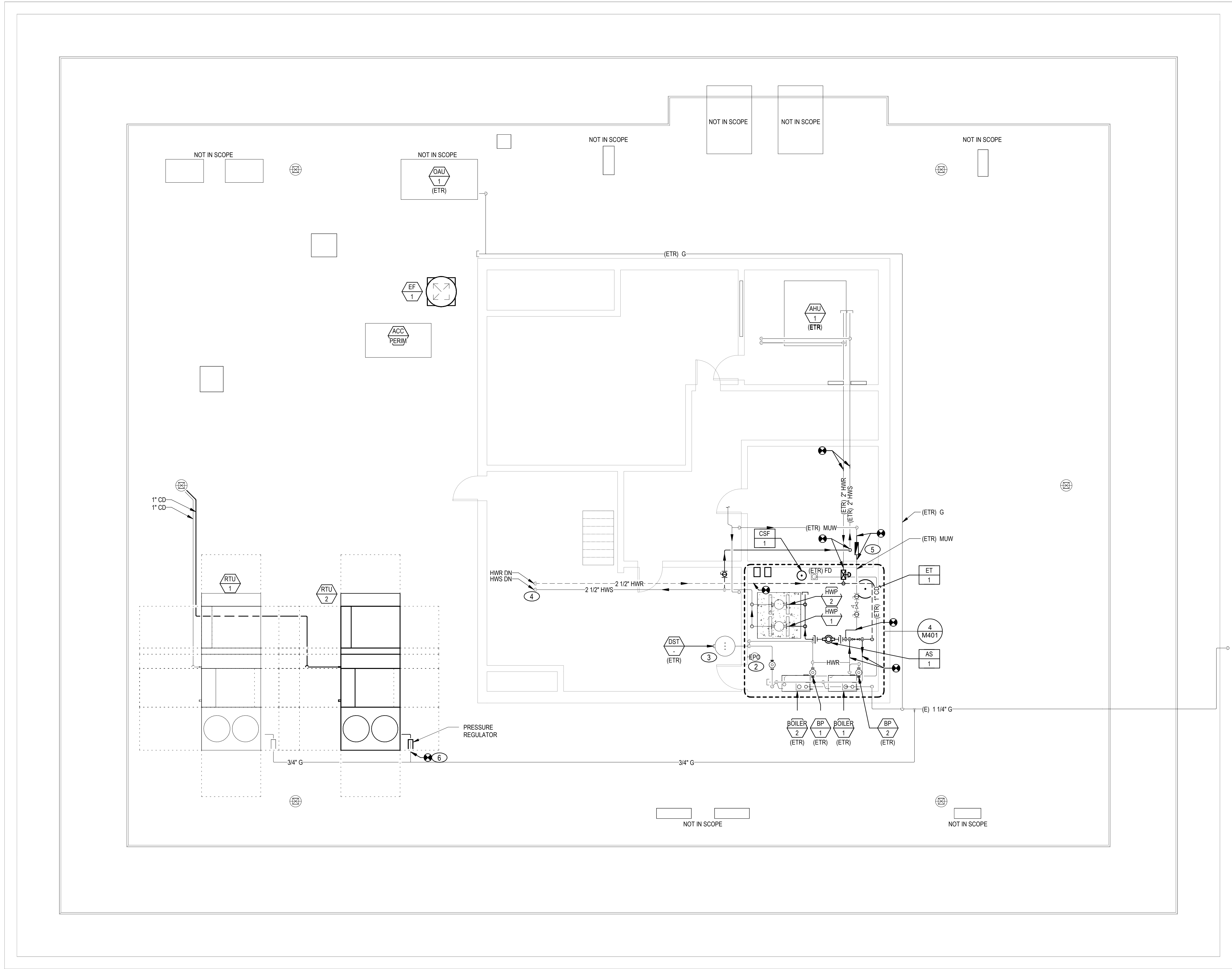
MECHANICAL
PIPING PLAN -
LEVEL 2 -
PHASE II

SHEET NUMBER

M201-2

Autodesk DWG2PDF 15.0 - 04/2008 (2) - GUC Admin Building HVAC Upgrade-0006120 - GUC Admin Building HVAC Upgrade - MEP/25-1
3/21/2025 11:32:17 AM

1 MECHANICAL PIPING PLAN - ROOF - PHASE II
M202-2 3/16" = 1'-0"



SHEET NOTES - HVAC:

(NOT ALL NOTES APPLY TO THIS DRAWING)

- ALL RETURN GRILLES SHALL HAVE SOUND BOOTS ABOVE CEILING. REFER TO DETAIL 10 ON SHEET M501 FOR MORE INFORMATION.
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- ALL PIPING TO VAV BOXES SHALL BE MINIMUM 3/4".

PHASING SHEET NOTES - HVAC:

- BOILER ROOM PIPING SHALL BE INSTALLED AT THE BEGINNING OF PHASE 2 TO MINIMIZE DOWN TIME OF THIRD FLOOR RE-HEAT CAPABILITIES.

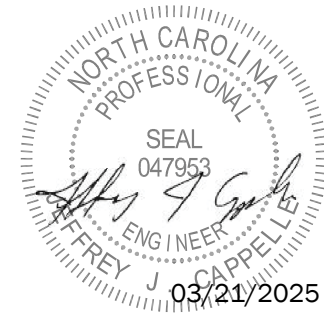
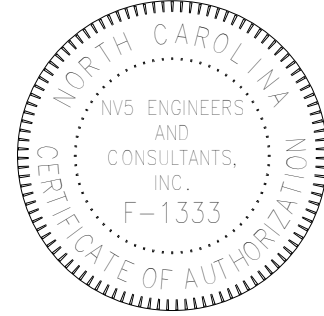
KEY NOTES

- CONDENSATE PIPING SHALL TERMINATE TO NEAREST ROOF DRAIN.
- EXISTING GAS SHUT OFF SHALL REMAIN. CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE DURING CONSTRUCTION.
- EXISTING PLUMBING SYSTEM (STORAGE TANK, PUMPS, PIPING AND ASSOCIATED VALVES) SHALL REMAIN. CONTRACTOR SHALL TAKE CARE NOT TO DAMAGE DURING CONSTRUCTION.
- HWS/R PIPING DOWN TO FLOOR BELOW.
- INSTALL NEW BACKFLOW PREVENTER (BFP) IN EXISTING TO REMAIN MAKEUP WATER LINE. BFP SHALL BE EQUAL TO **WATTS SERIES LE009** WITH QUARTER TURN BALL VALVES AND STRAINER. INCLUDE WATTS AIR GAP ACCESSORY MODEL #909AGA. PIPE ASSOCIATED DRAIN TO NEAREST FLOOR DRAIN.
- PROVIDE NATURAL GAS REGULATOR AT EACH PIECE OF EQUIPMENT. GAS REGULATOR SHALL BE MAXITROL MODEL NUMBER 325-SL48 (3/4"x3/4", 14"WC) WITH OP48 AND VENT PROTECTOR 13A15-5. INSTALL PER MANUFACTURER REQUIREMENTS.

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PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

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1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120

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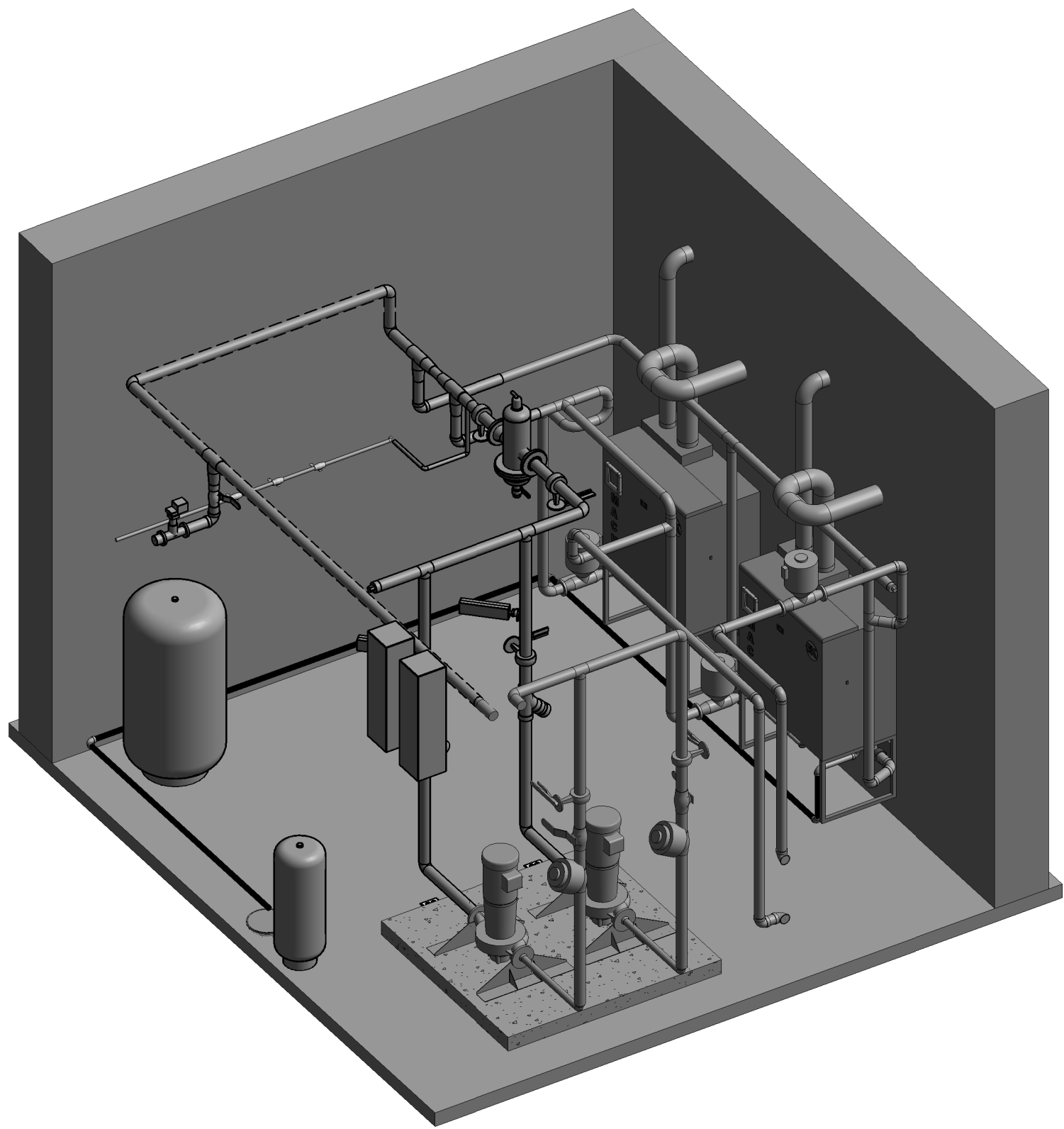
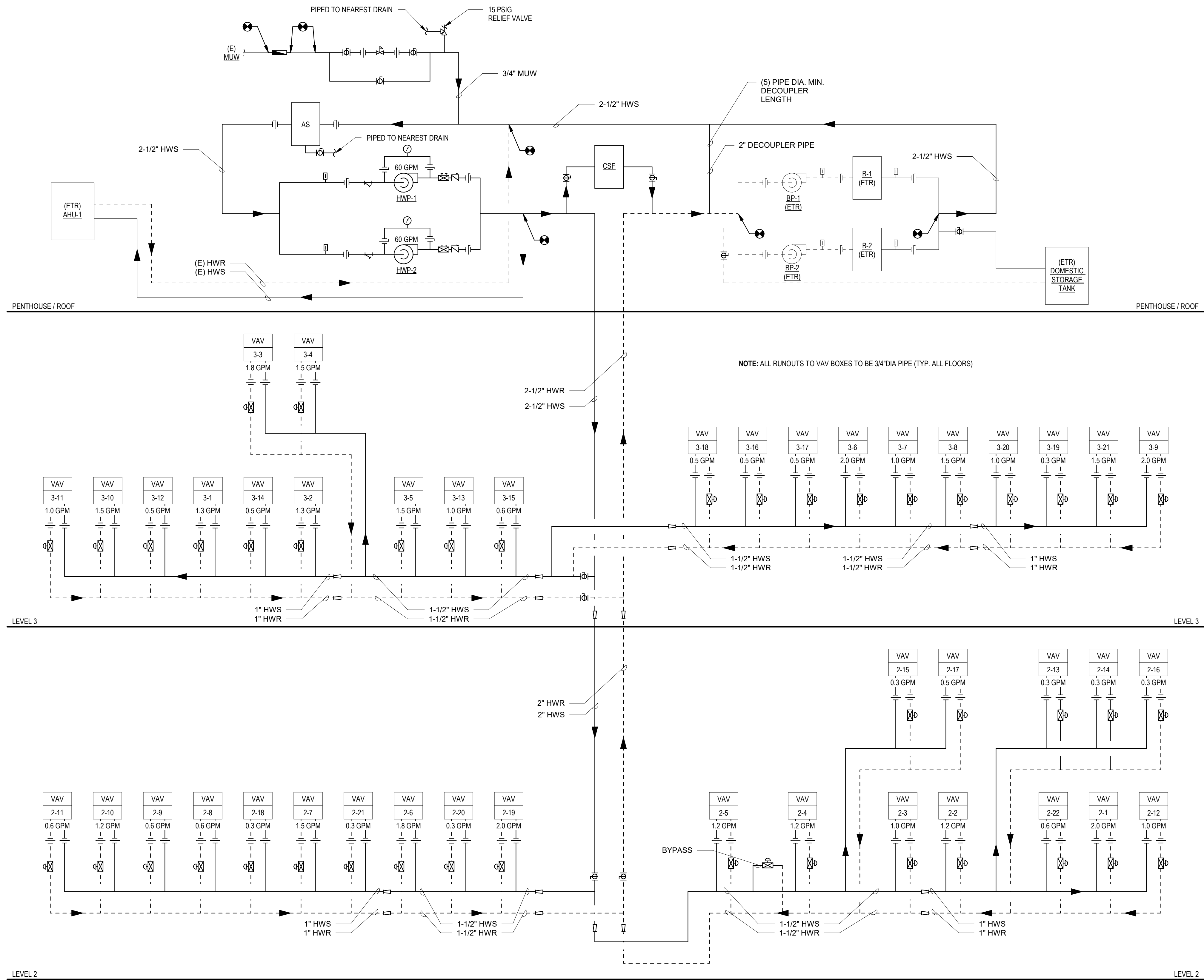
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MECHANICAL
PIPING PLAN -
ROOF - PHASE II

SHEET NUMBER

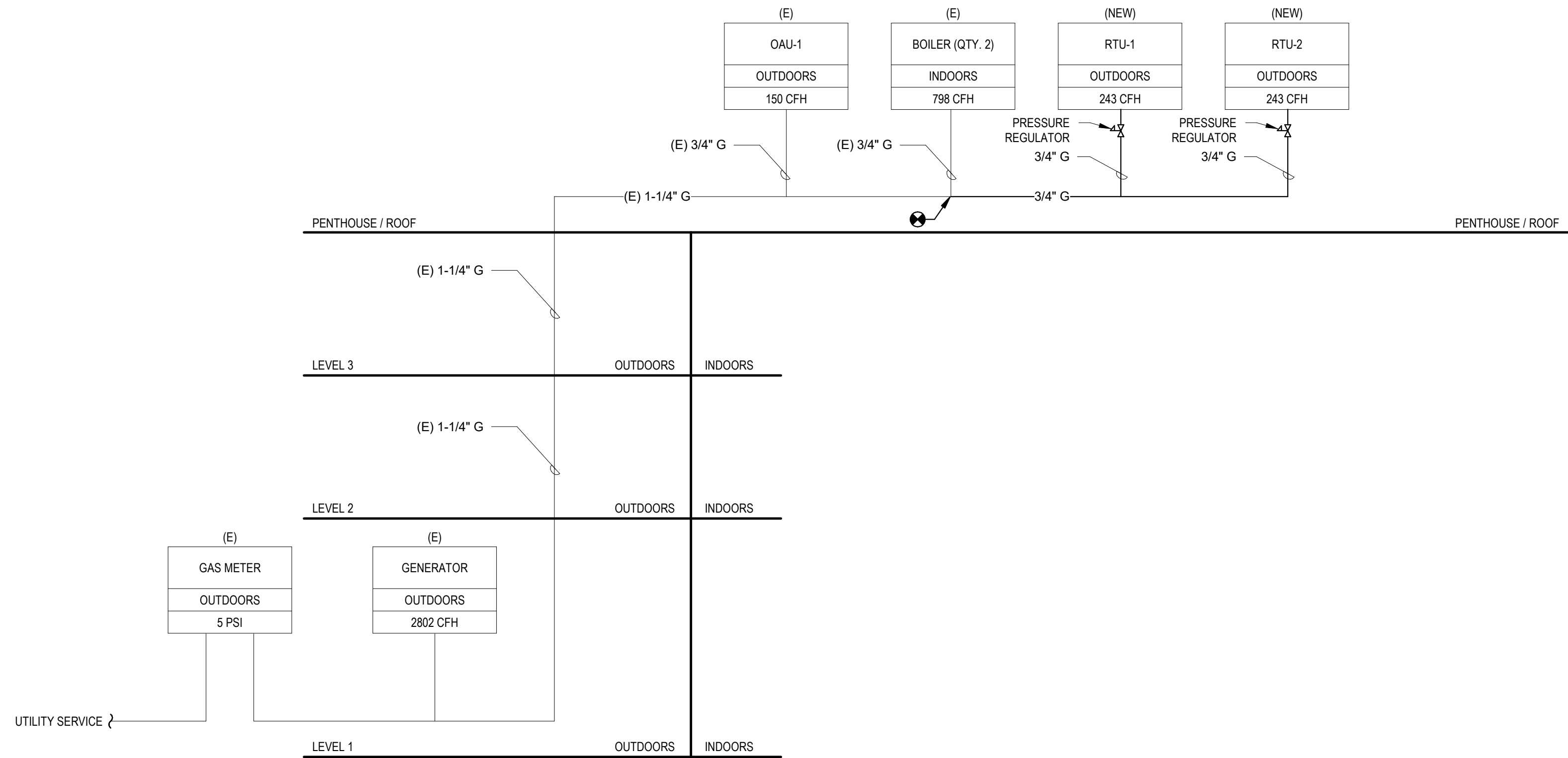
M202-2

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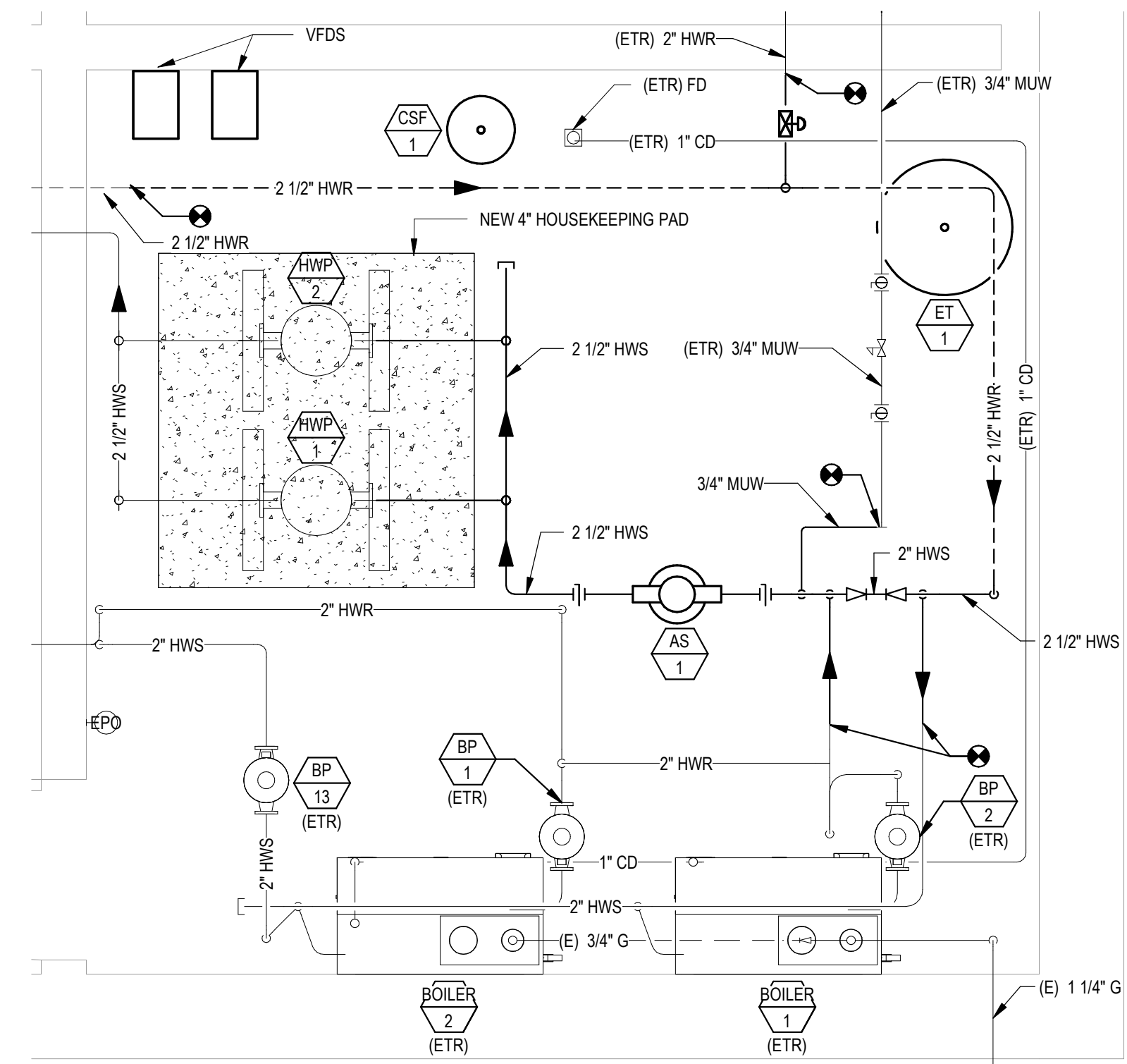


1 PENTHOUSE BOILER ROOM PIPING ISO
M401

2 HW FLOW DIAGRAM
M401 1/8" = 1'-0"



3 NATURAL GAS RISER DIAGRAM
M401 1/8" = 1'-0"

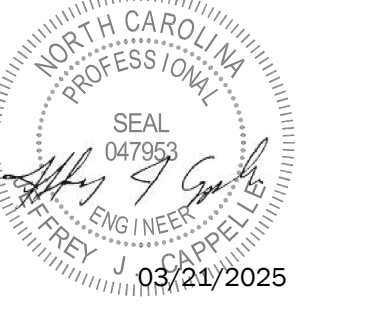
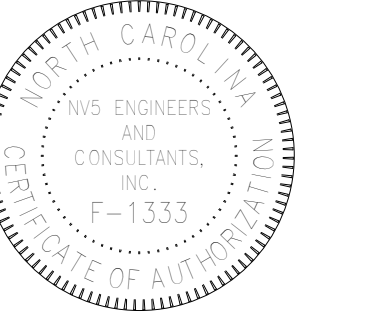


4 MECHANICAL PIPING PLAN - BOILER ROOM
ENLARGED - PHASE II
M401 1/2" = 1'-0"

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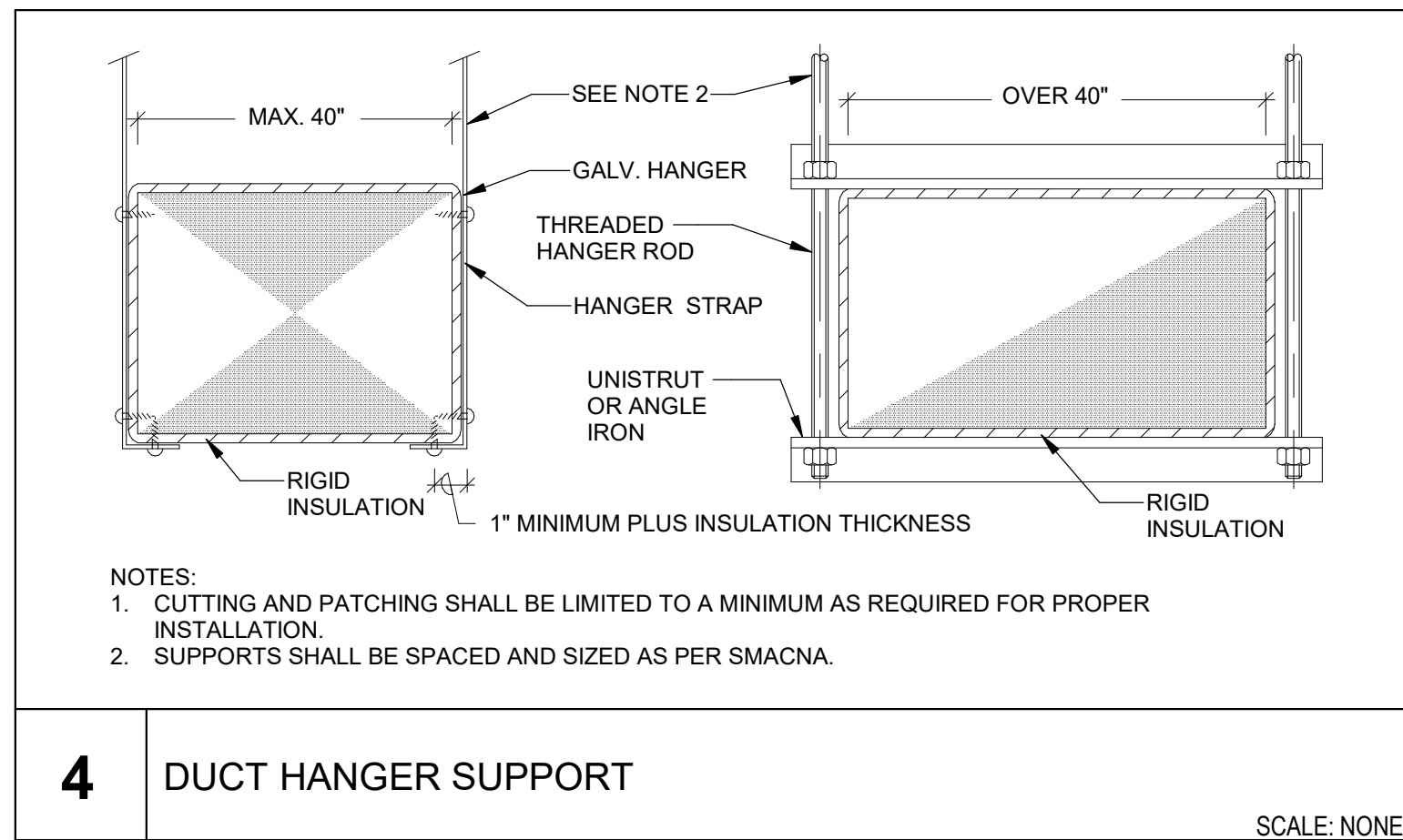
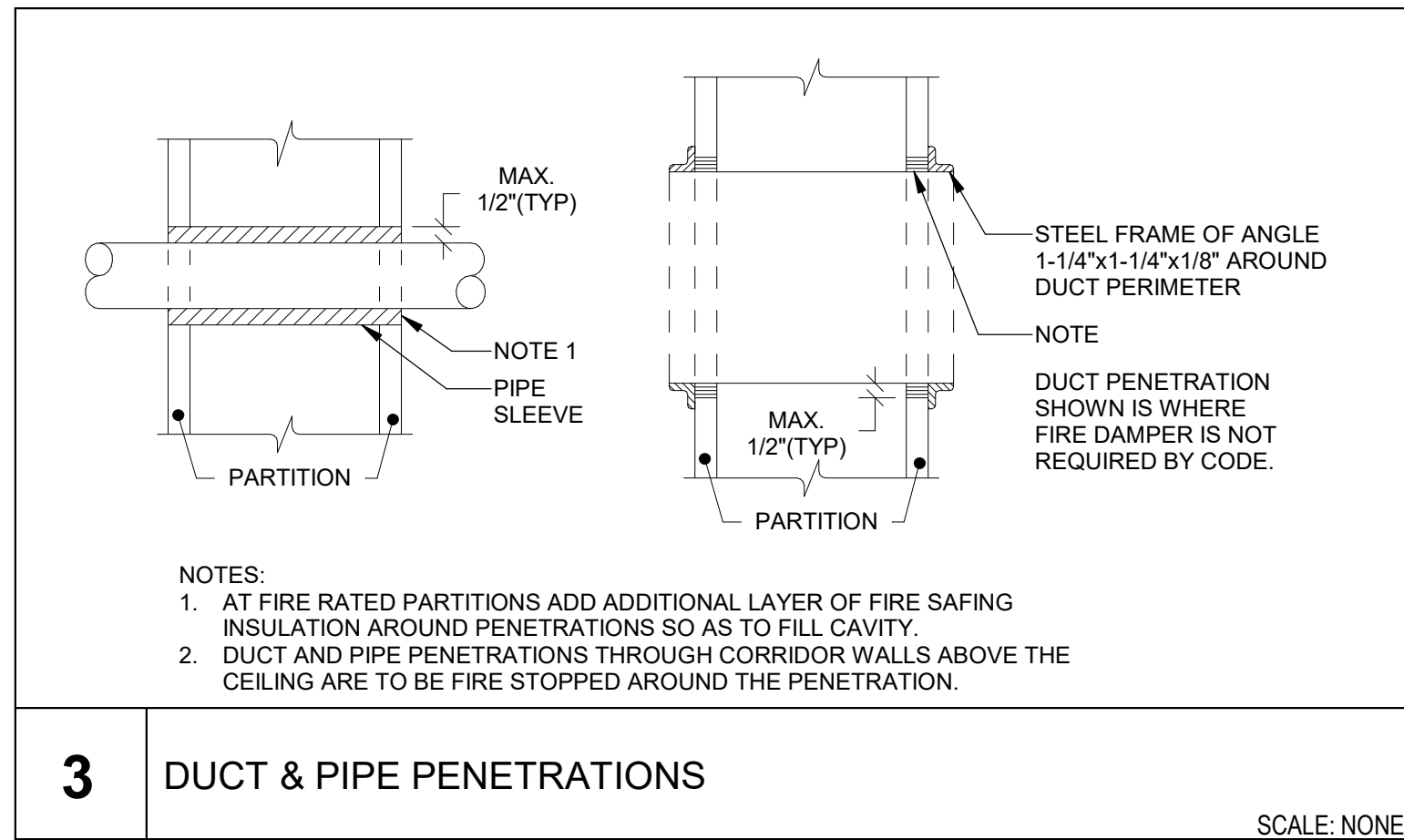
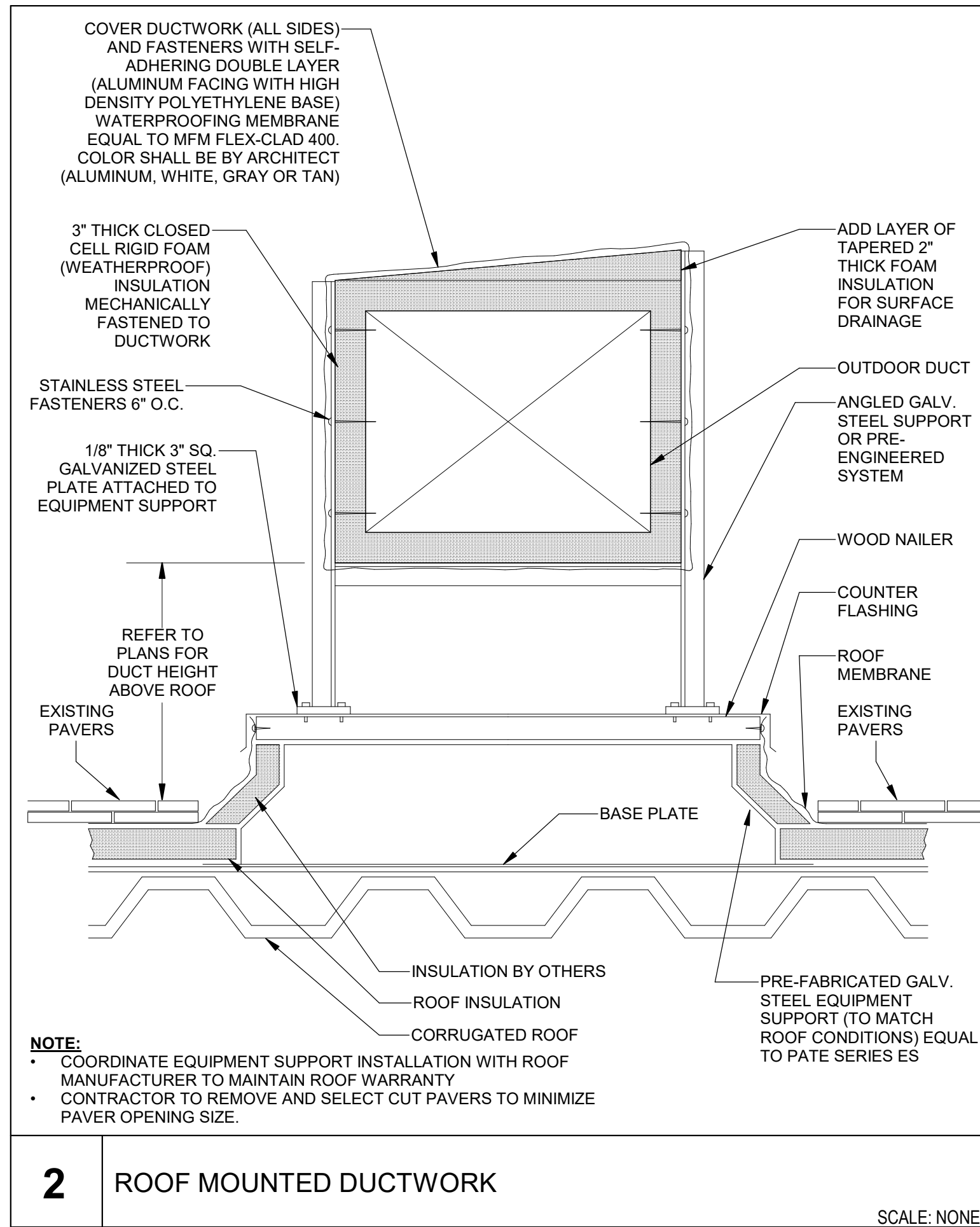
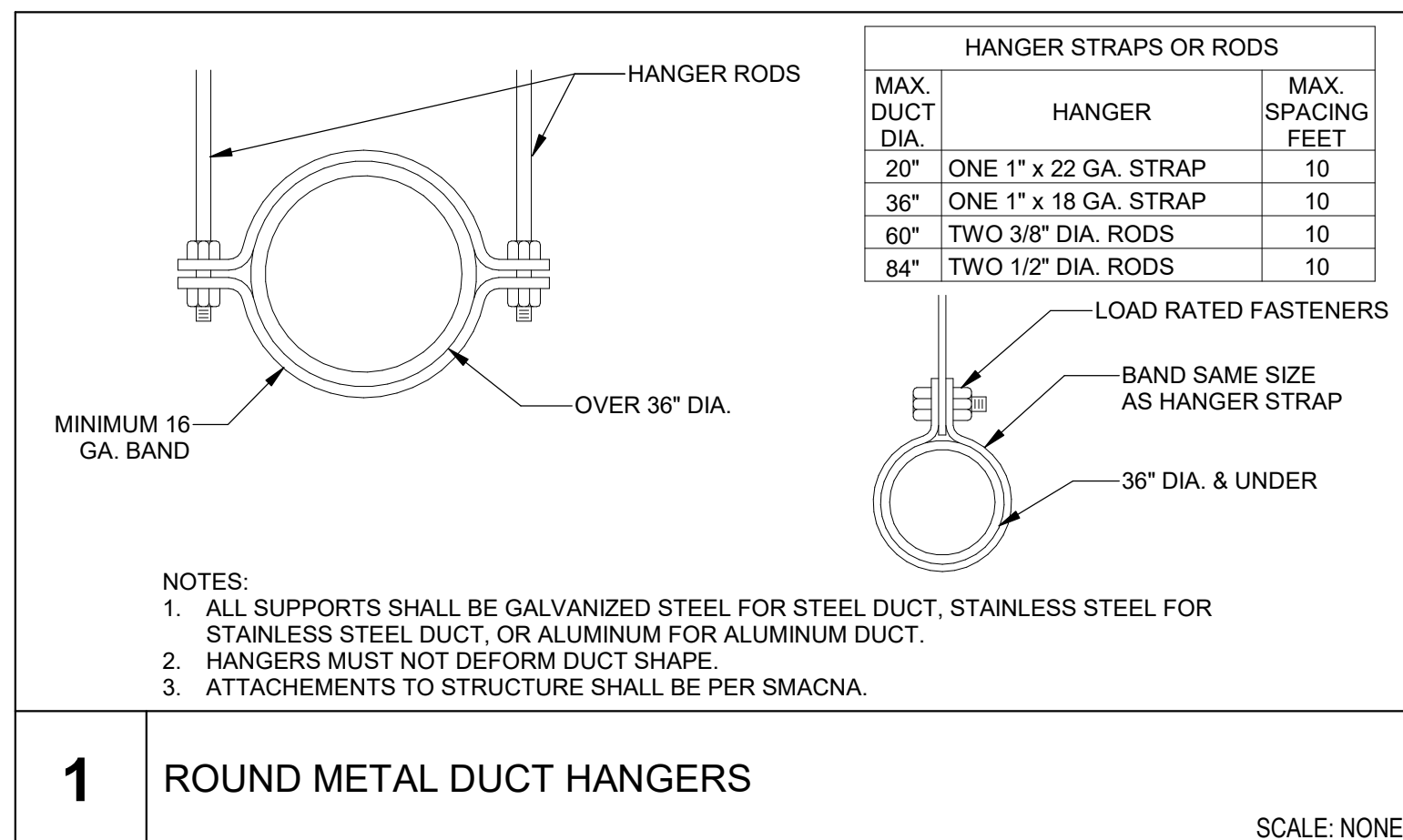
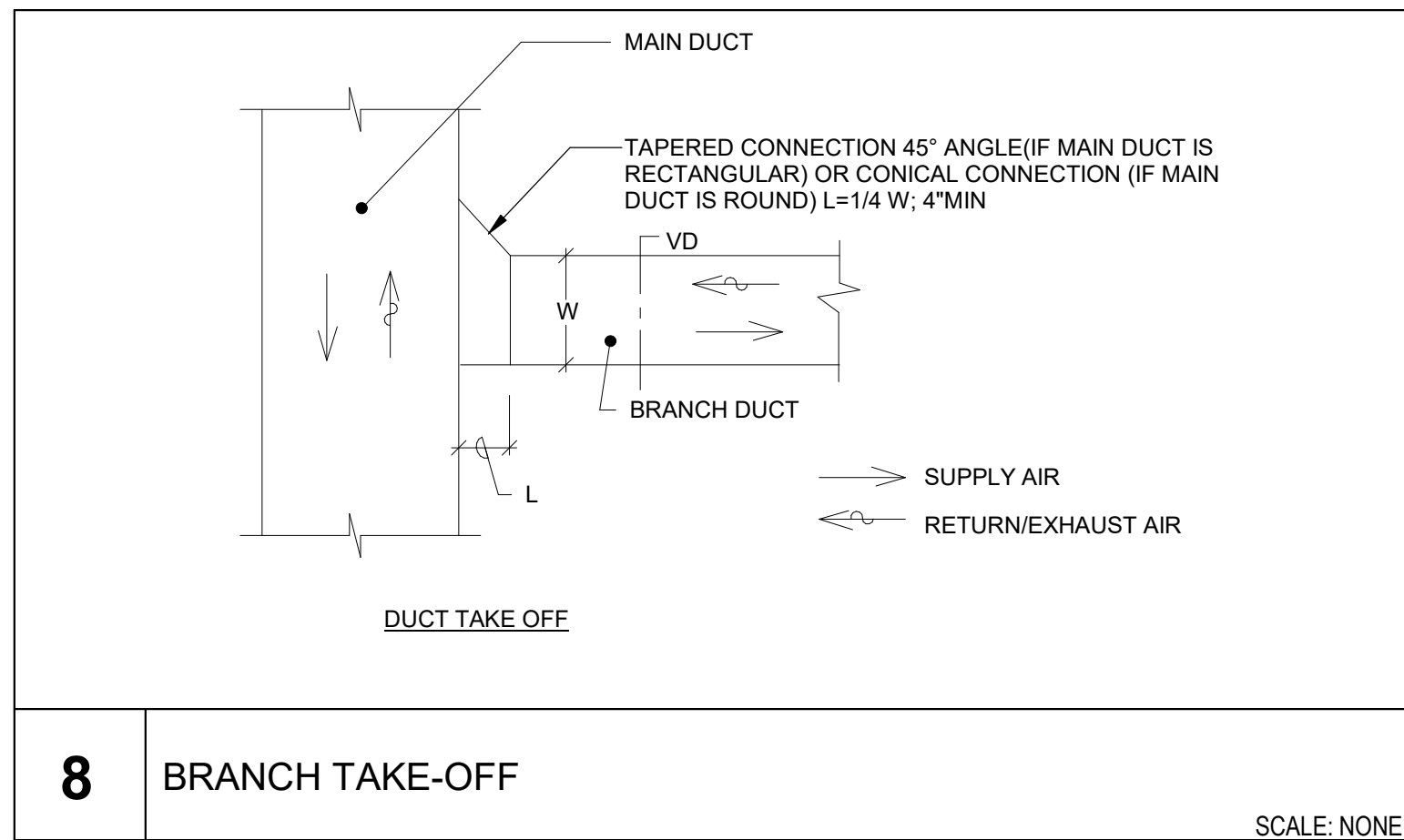
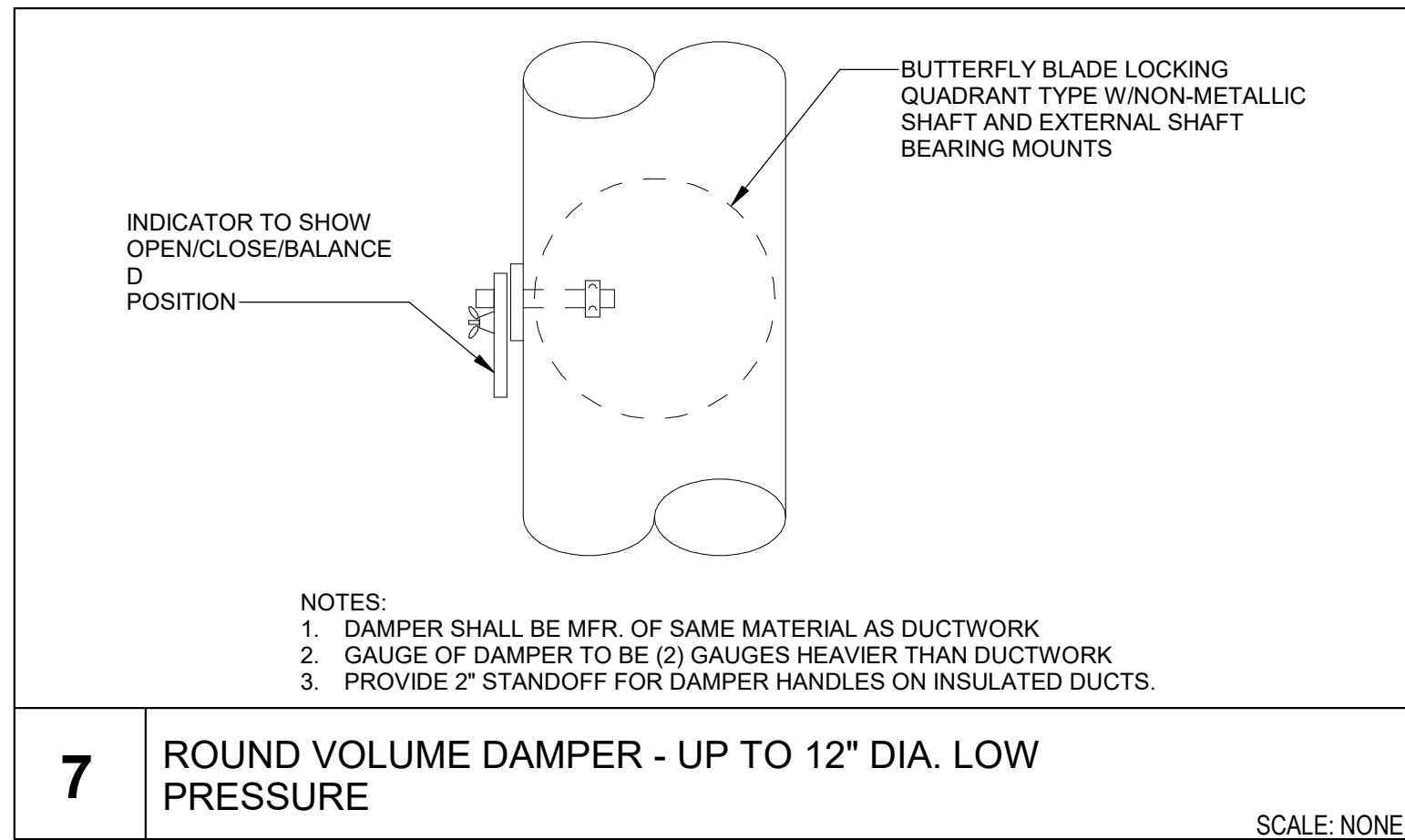
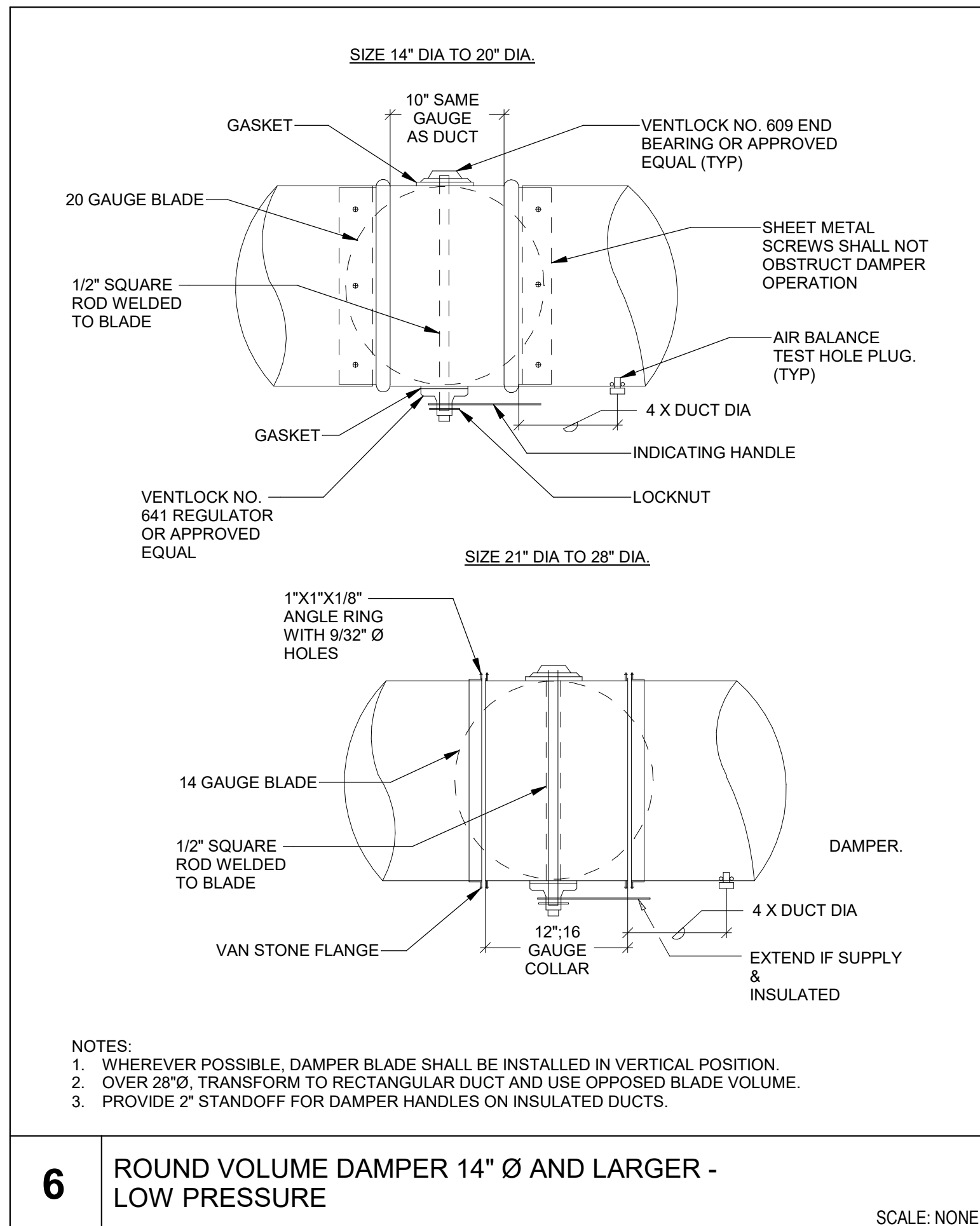
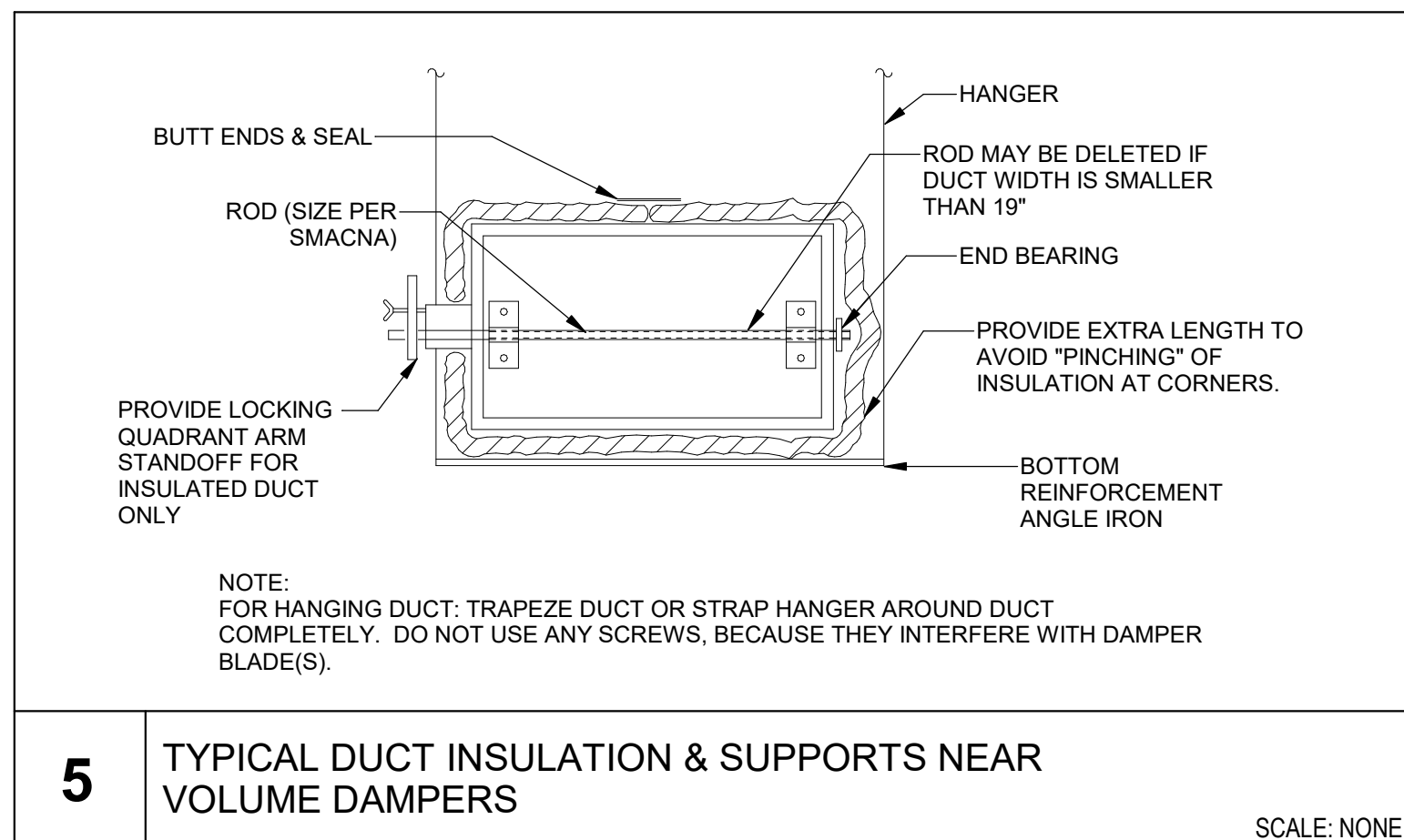
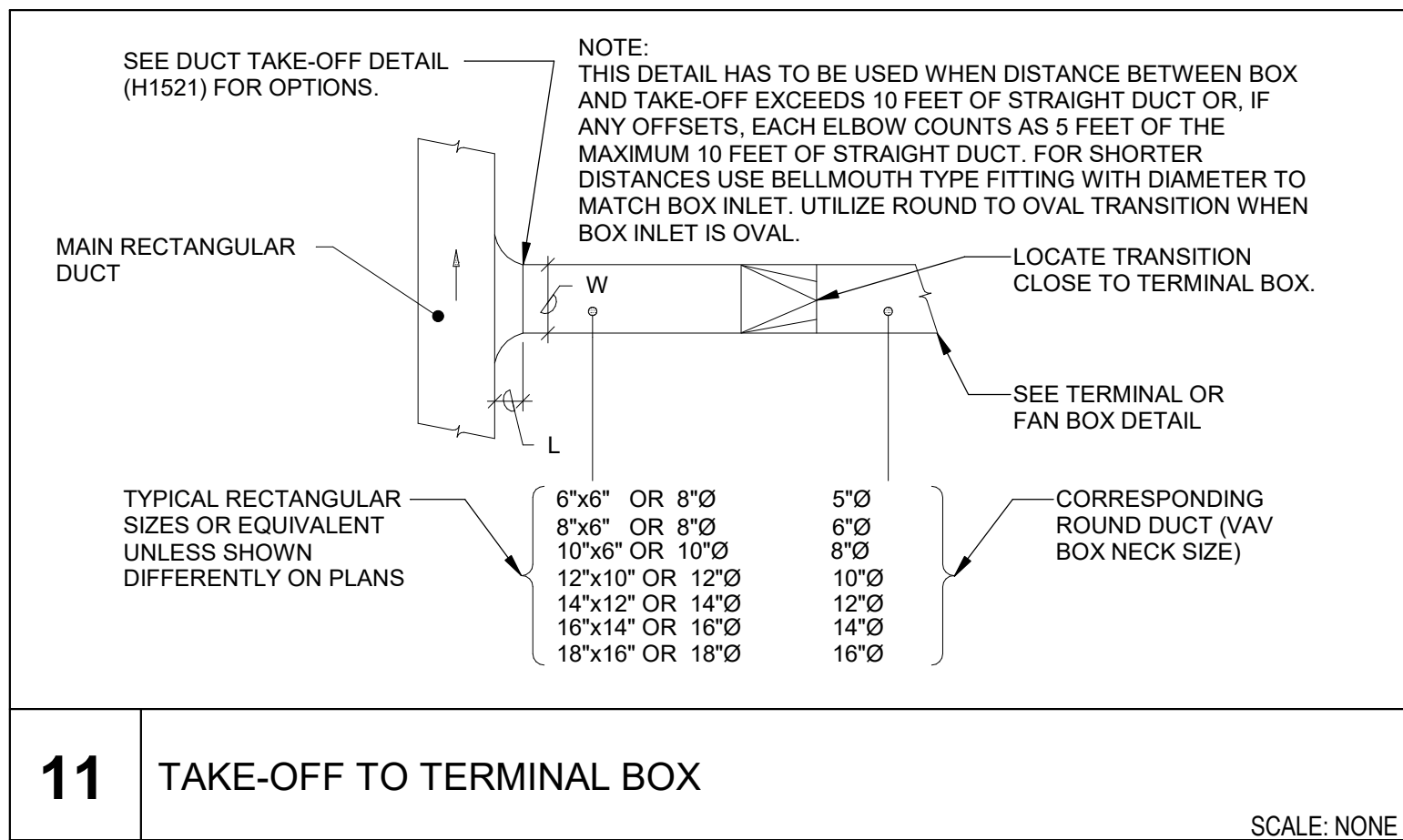
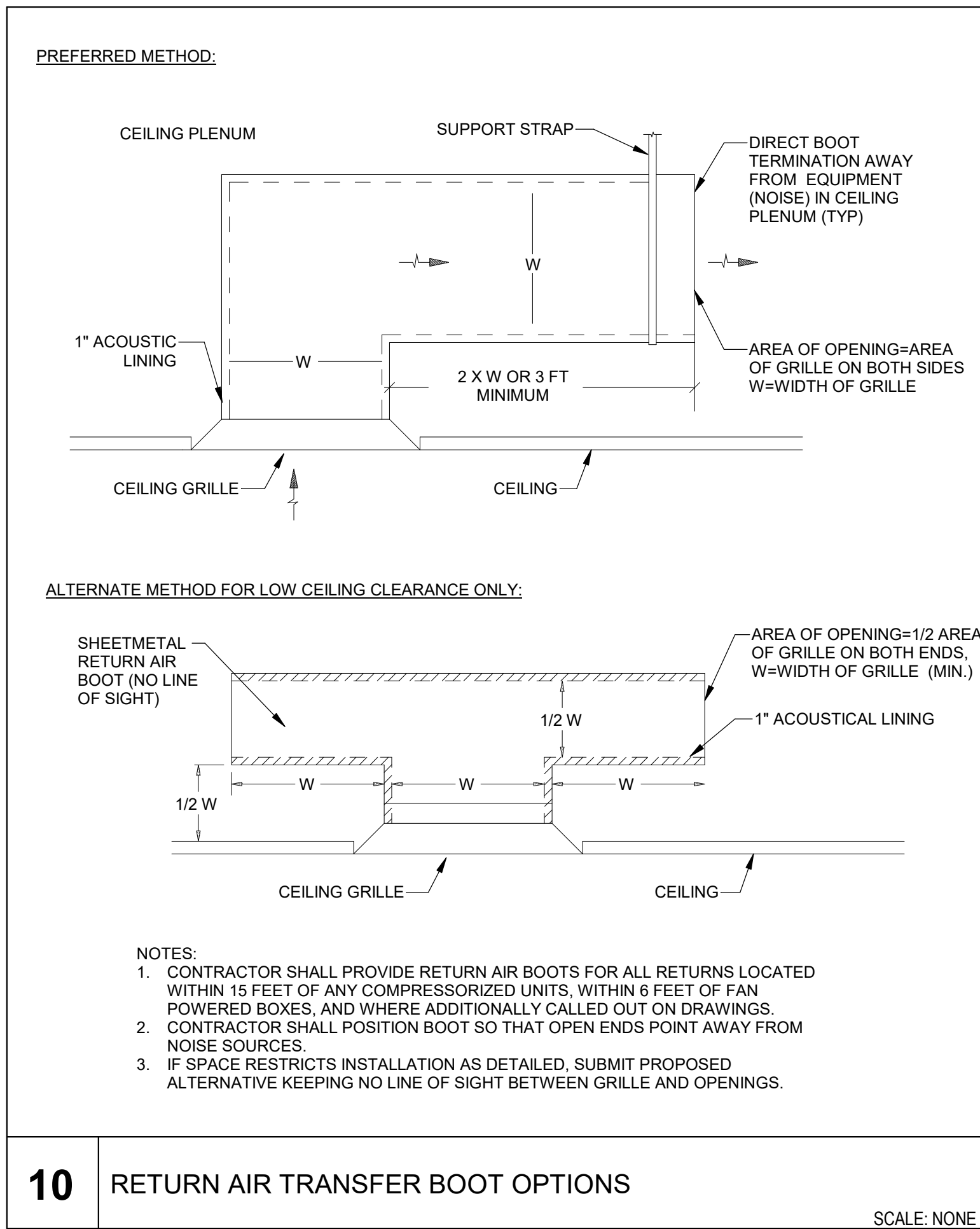
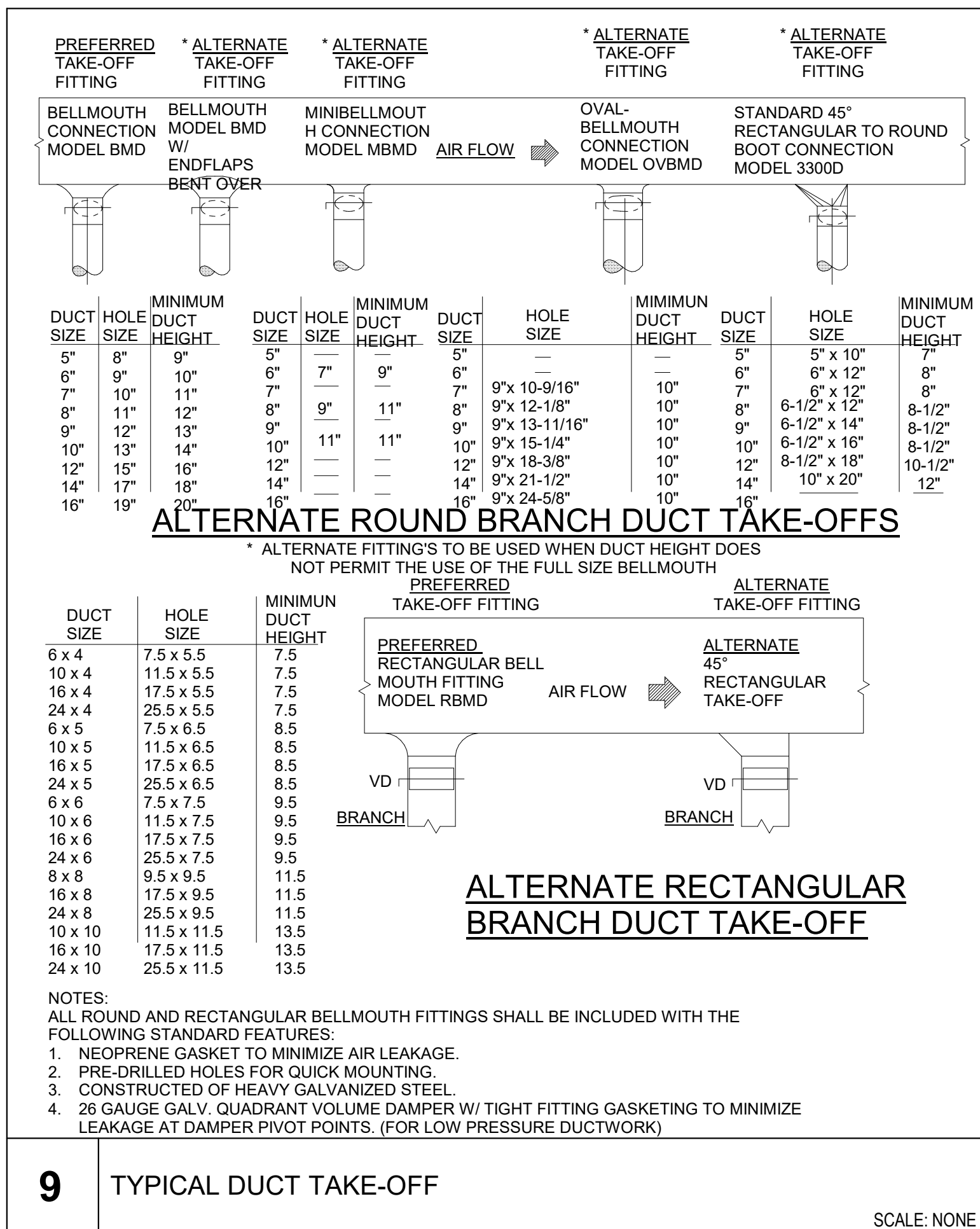
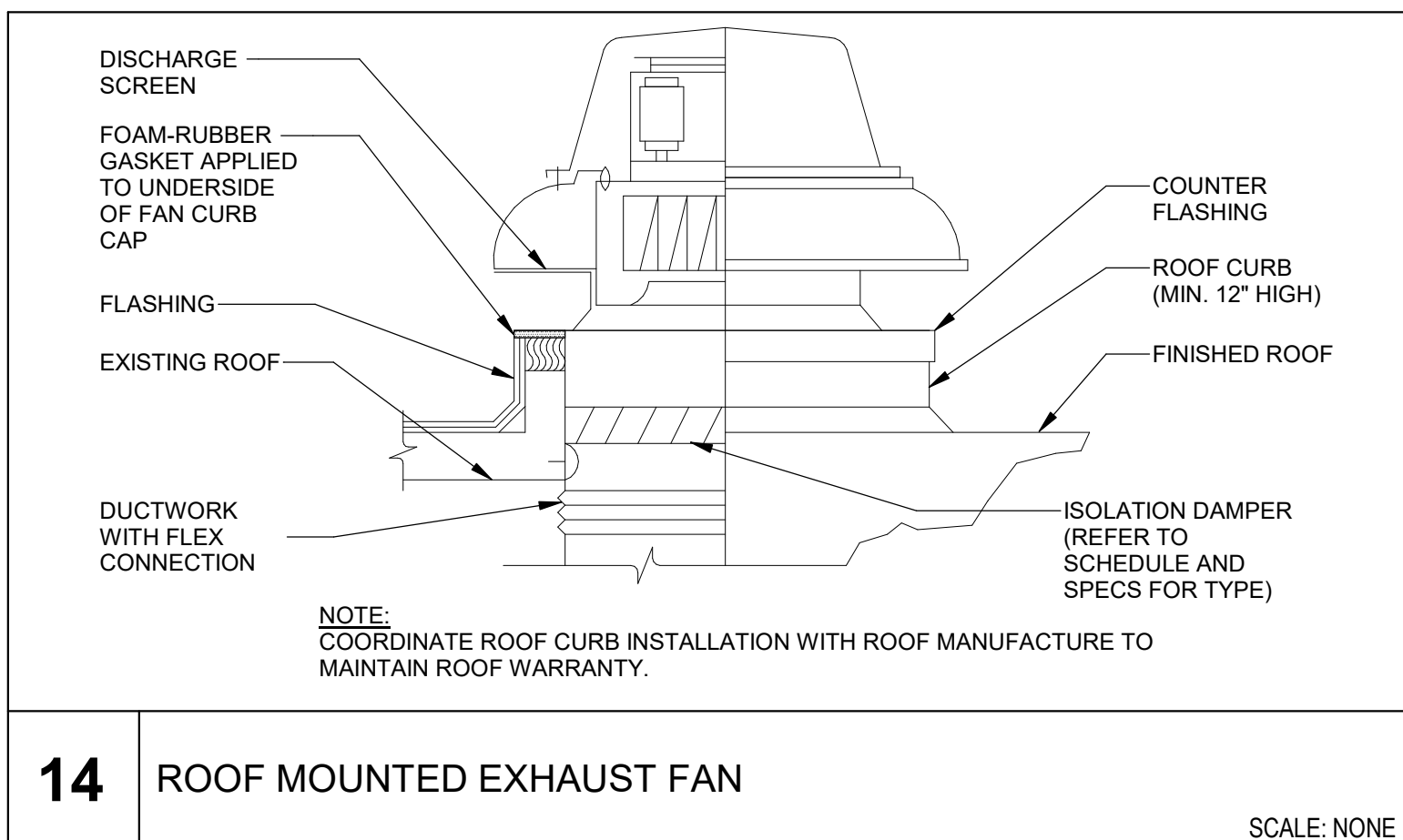
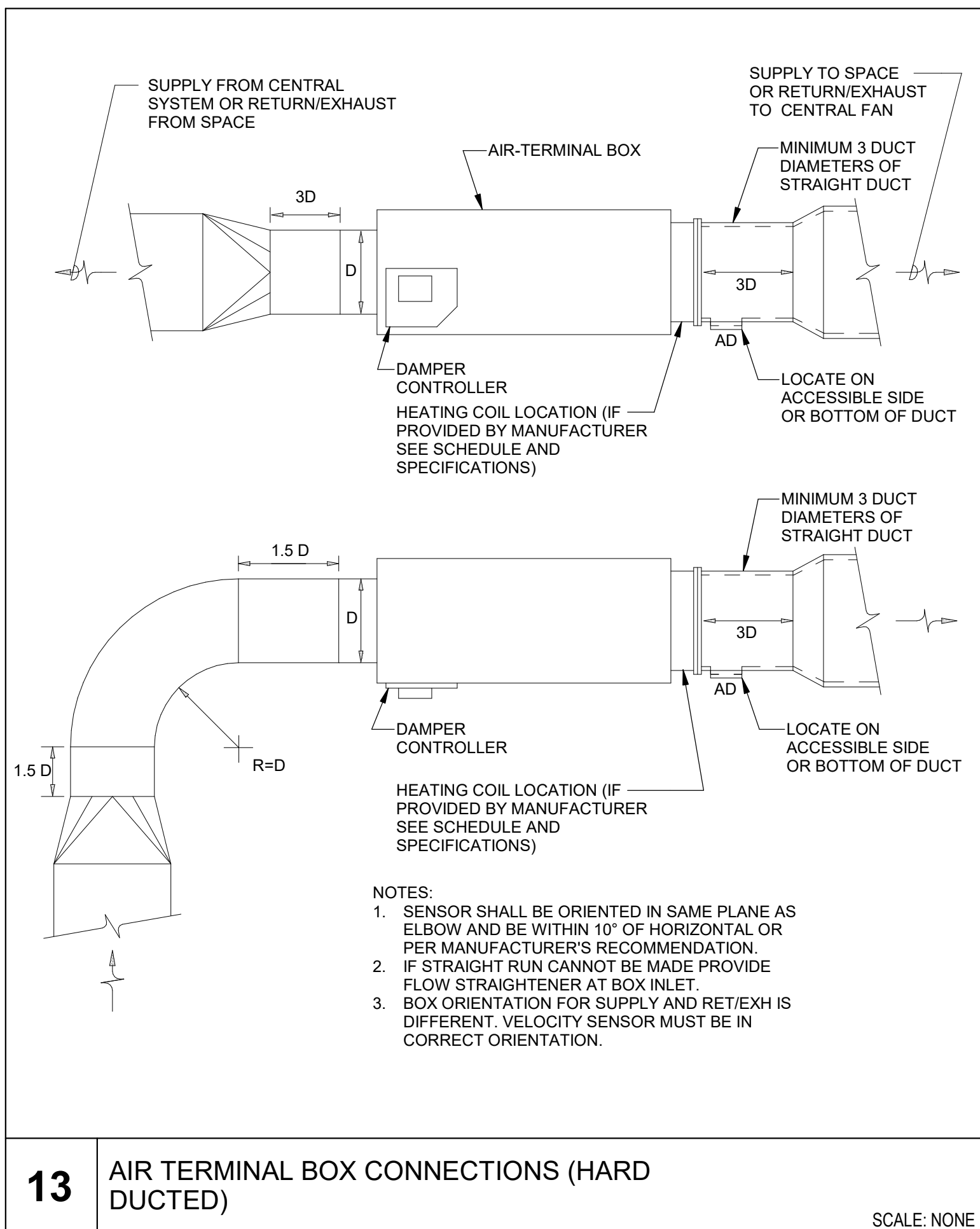
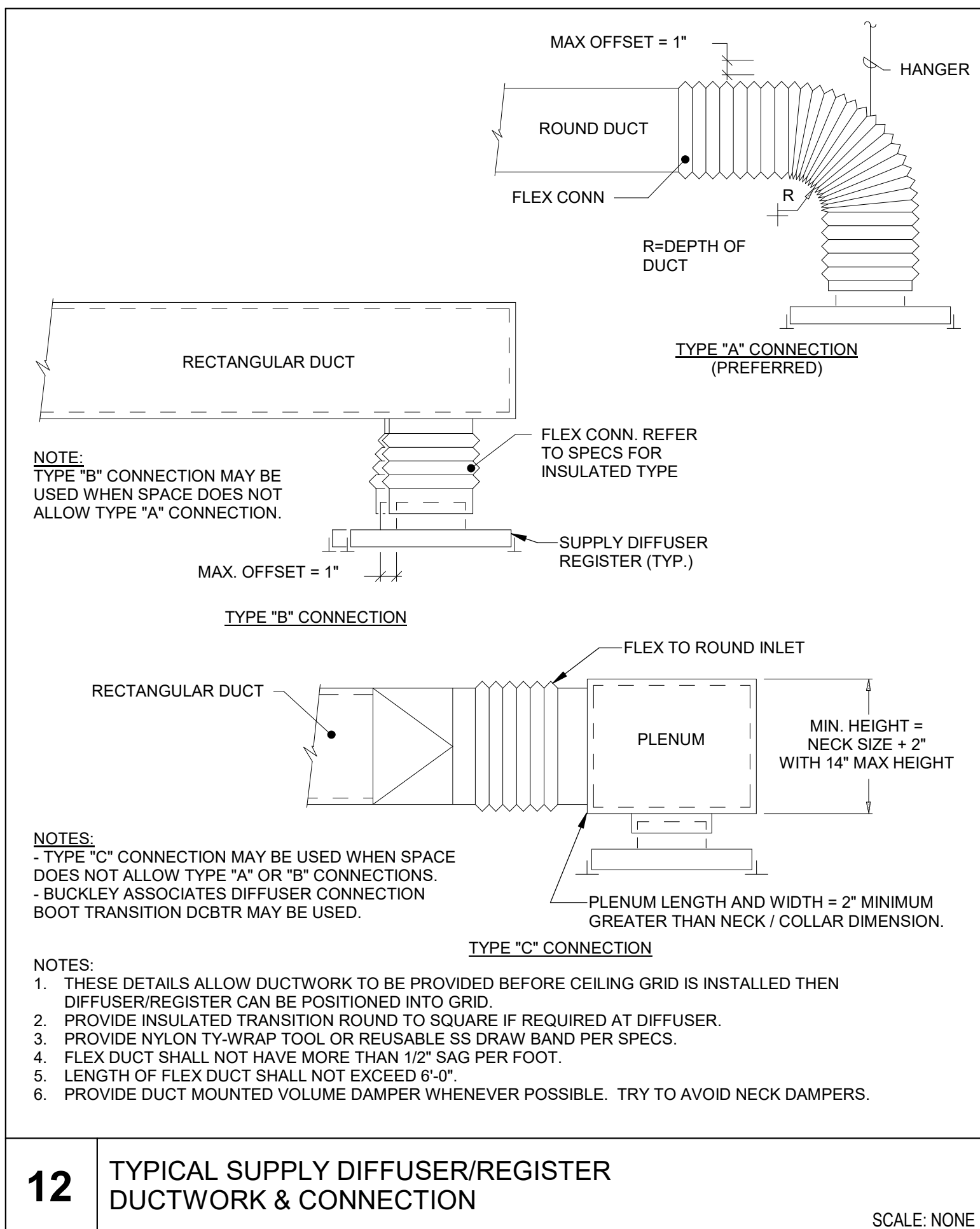
PROJECT NO.: 24-0006120
DESIGNED BY: IW
CHECKED BY: JUC
DATE: 03/21/2025
SCALE: NTS

SHEET NAME

MECHANICAL
RISERS AND
FLOW DIAGRAMS

SHEET NUMBER

M401



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CONSULTANT

PROJECT NAME

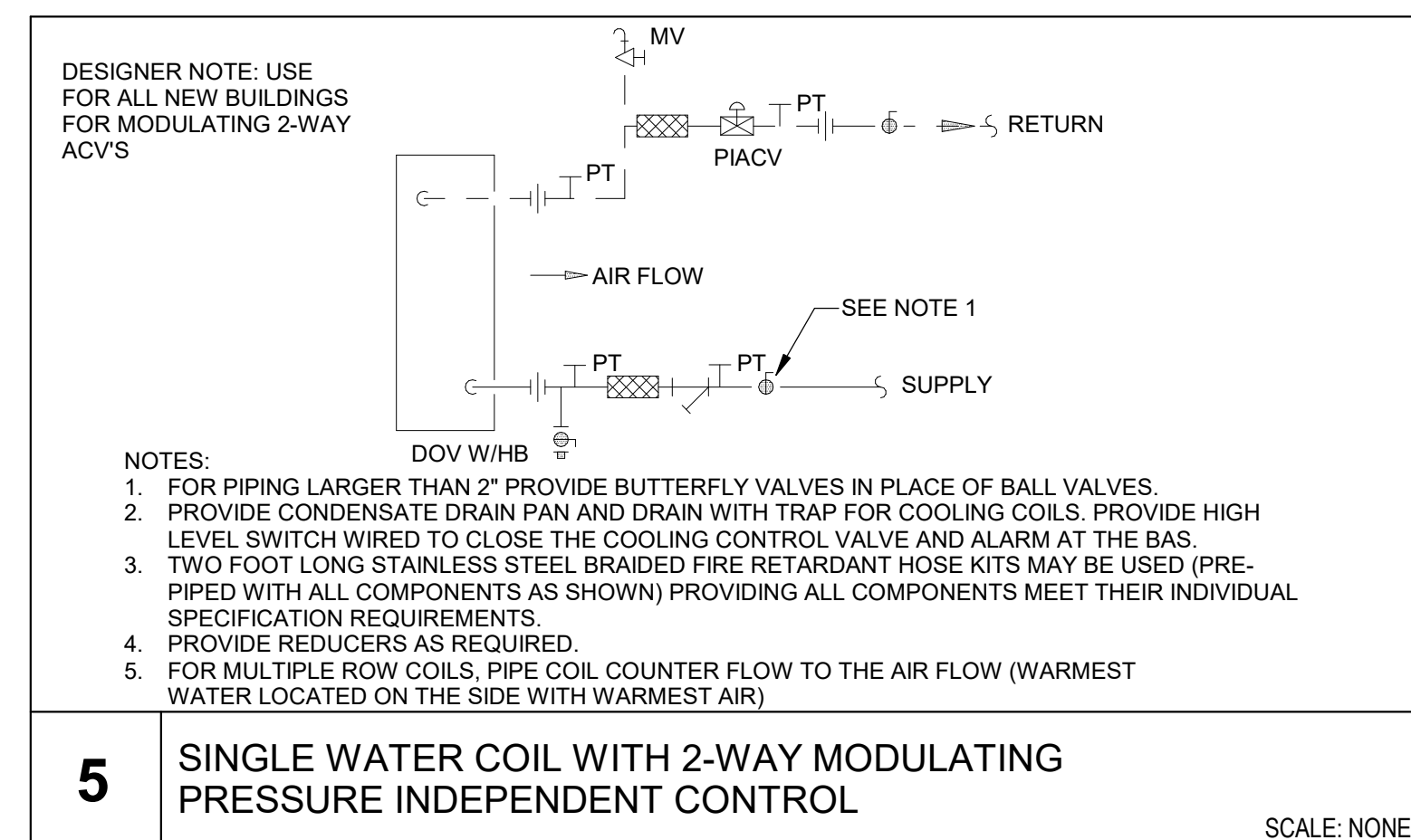
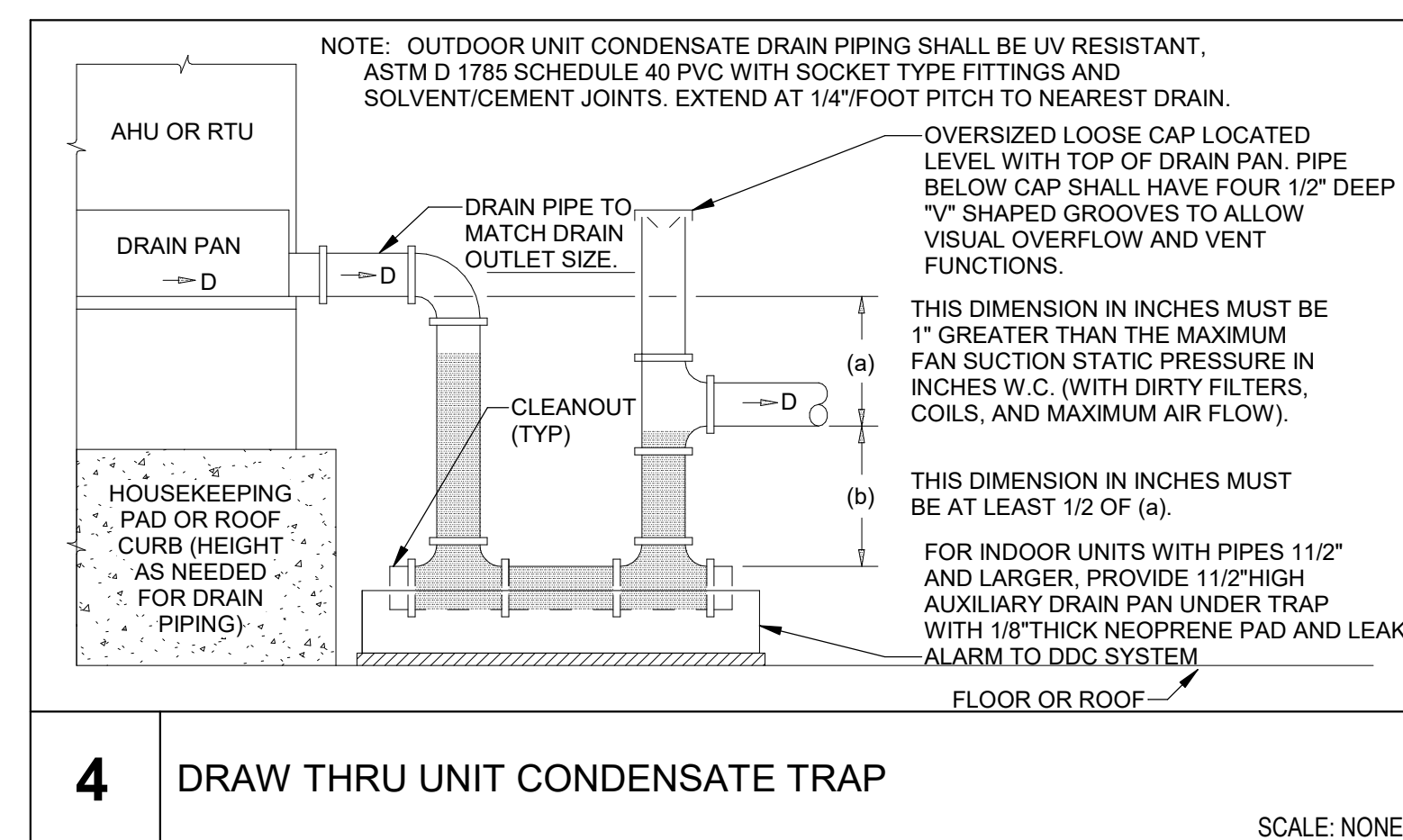
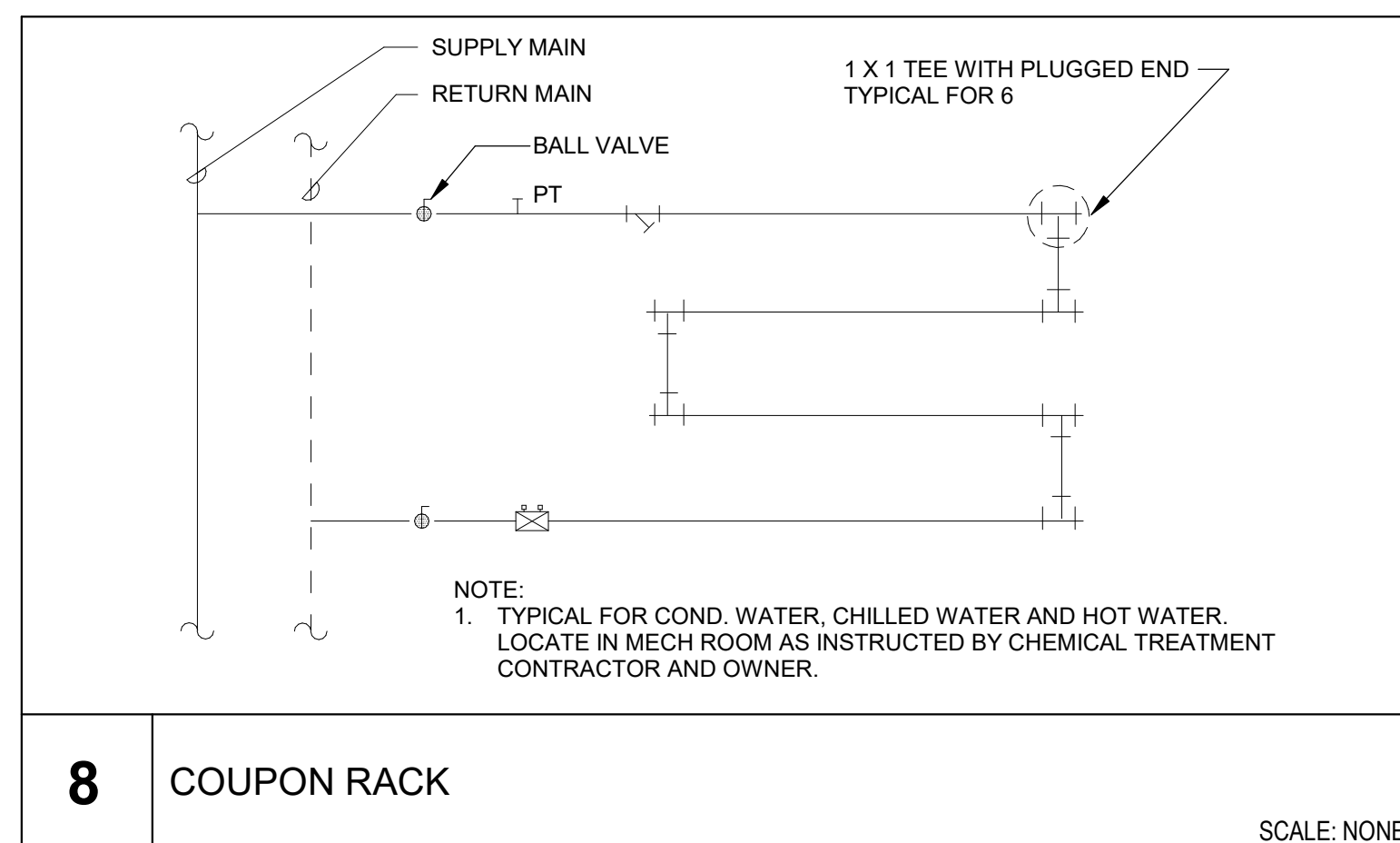
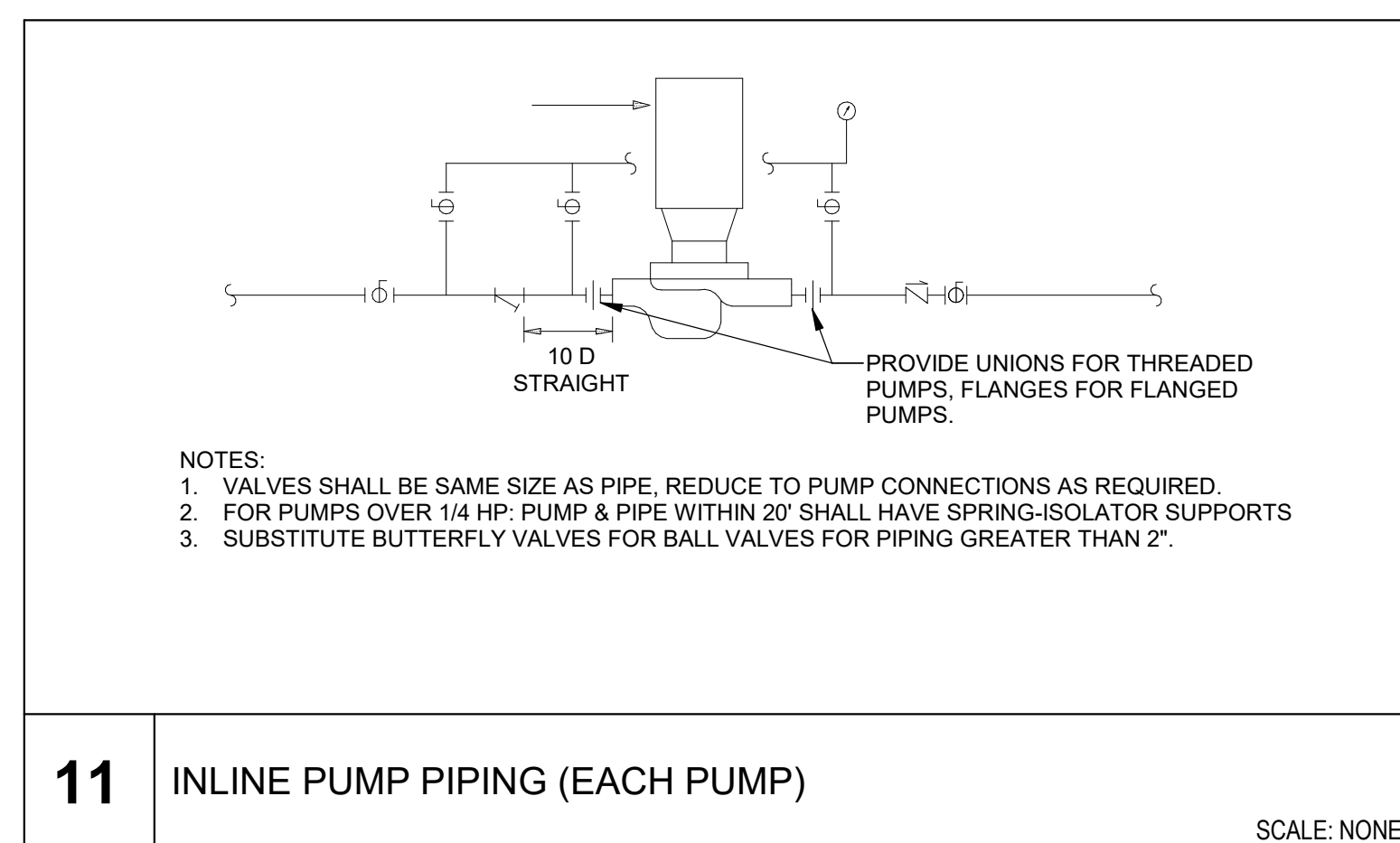
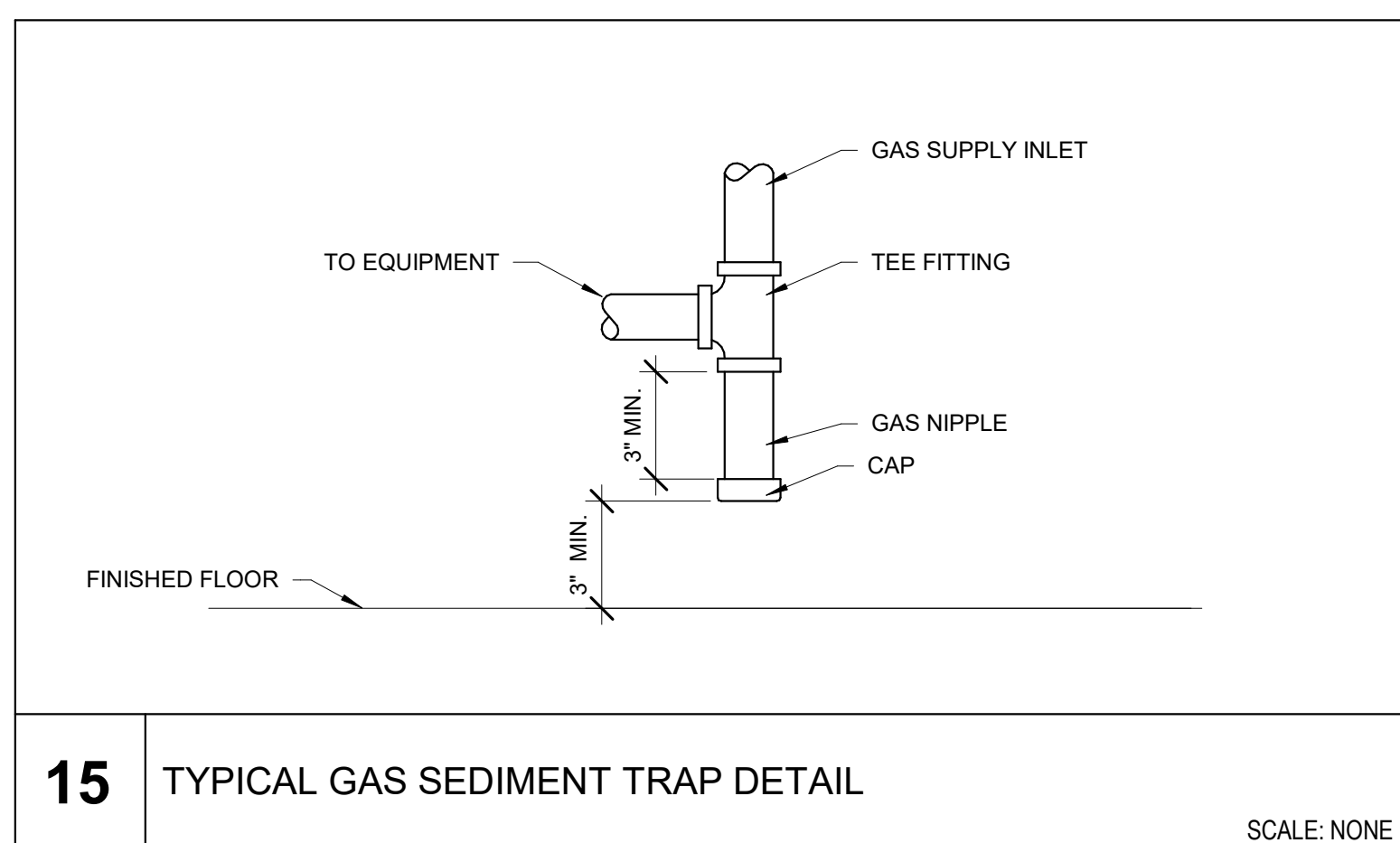
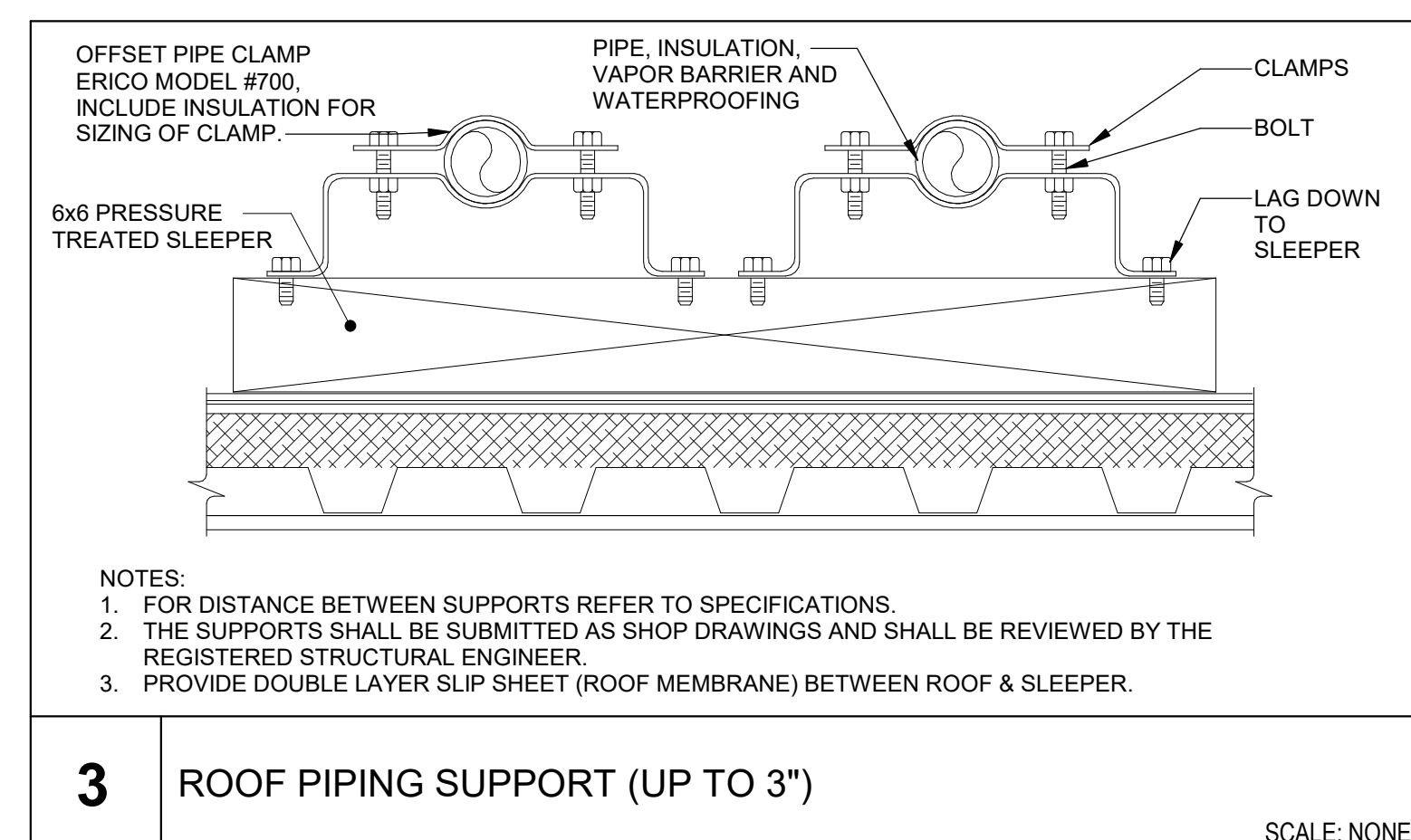
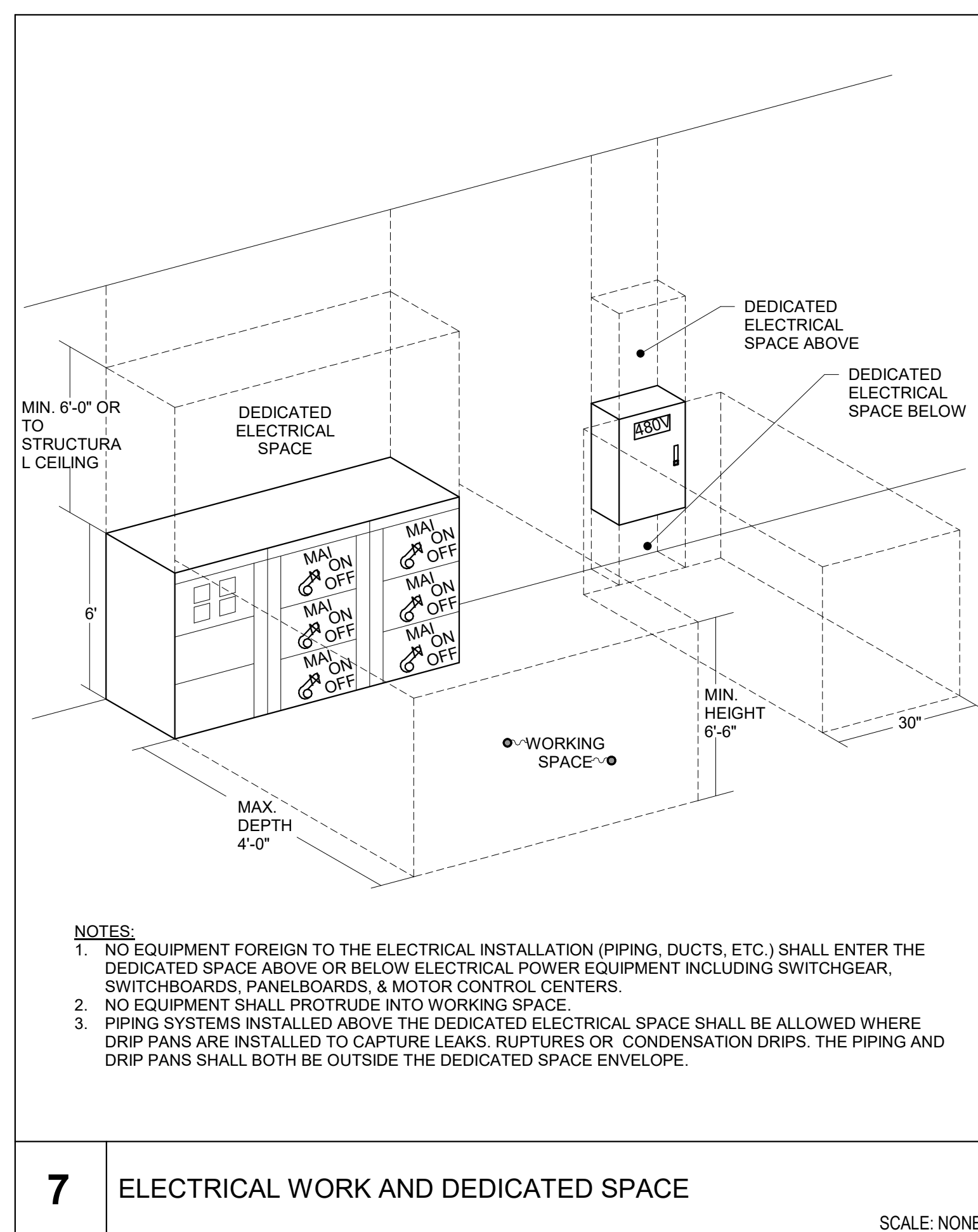
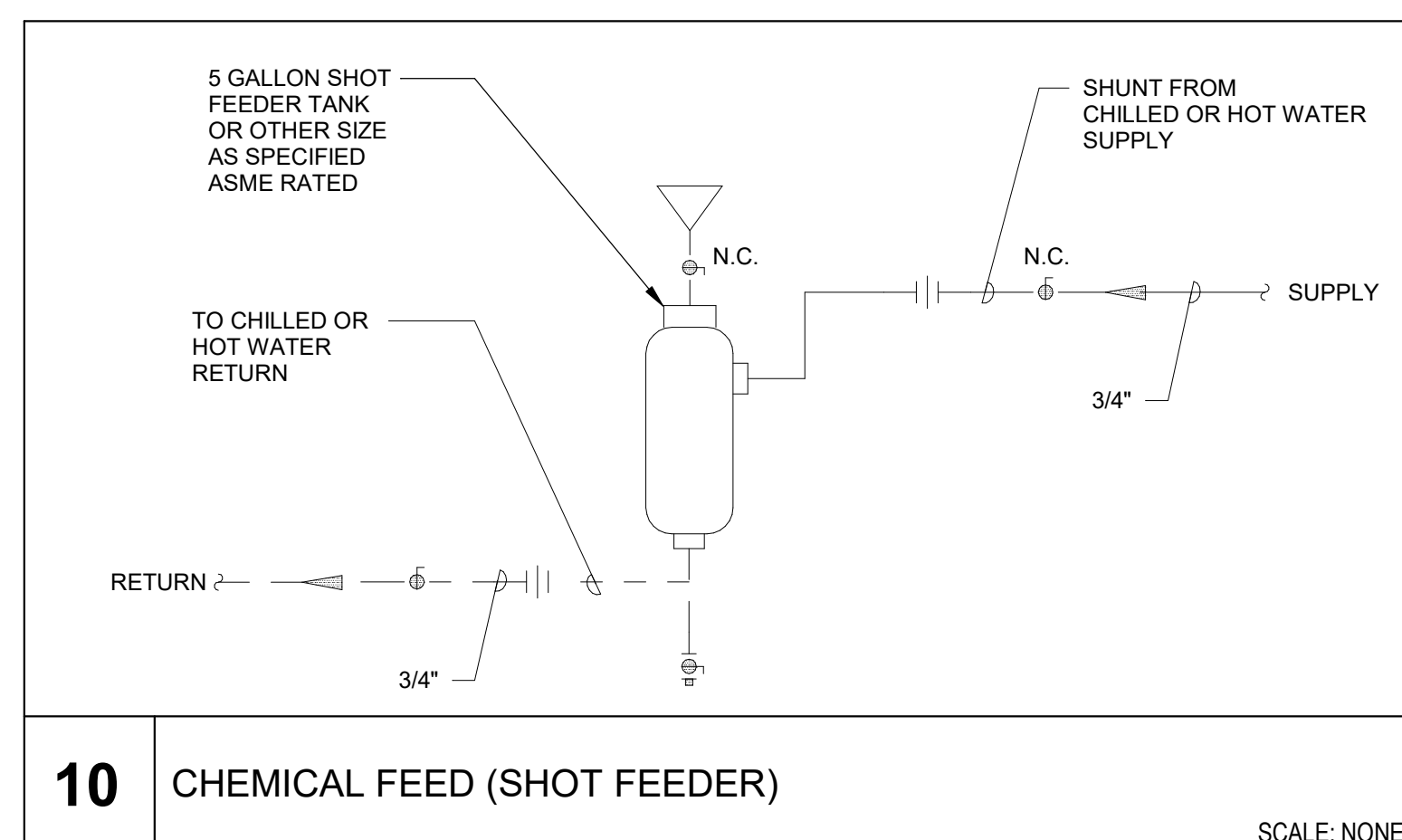
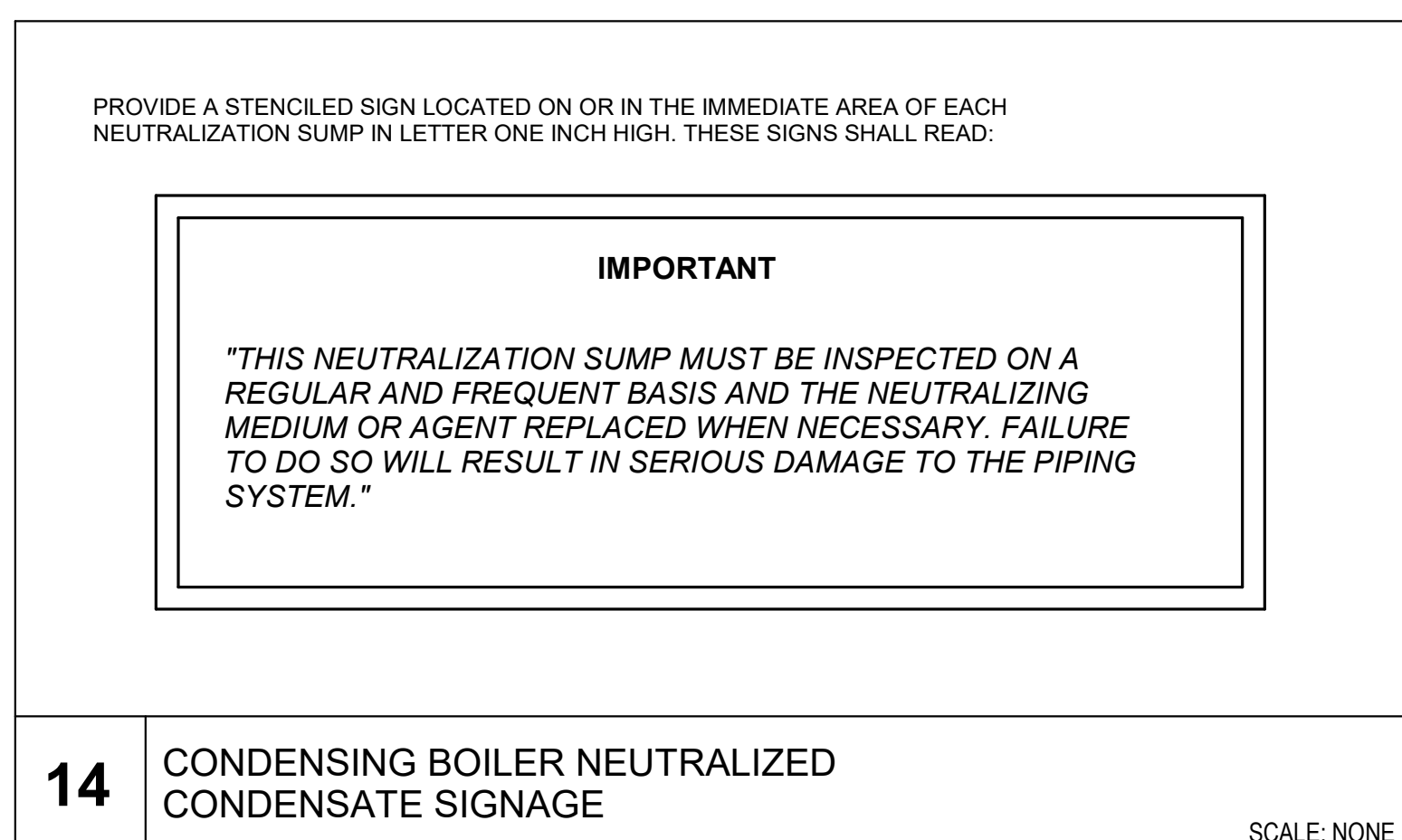
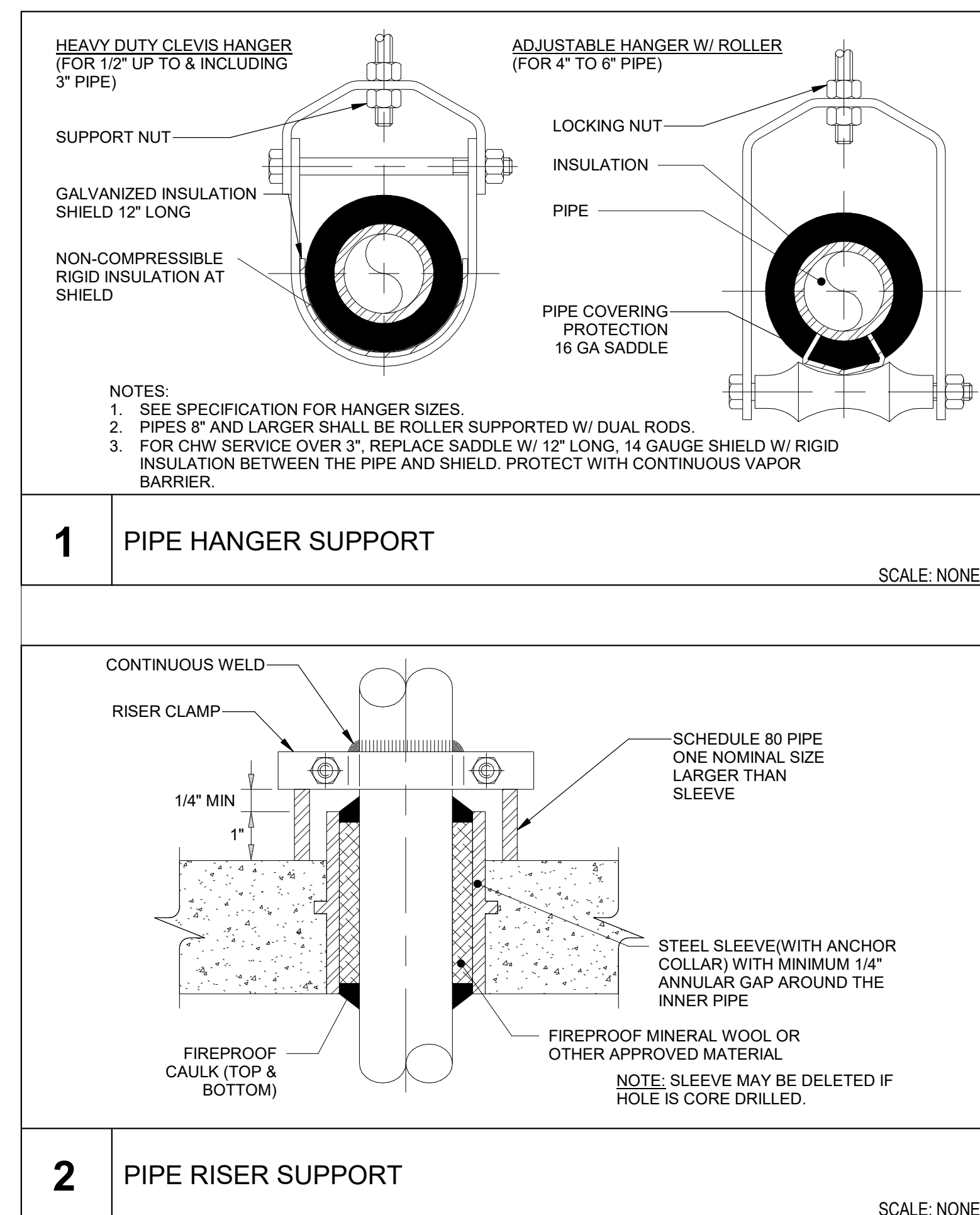
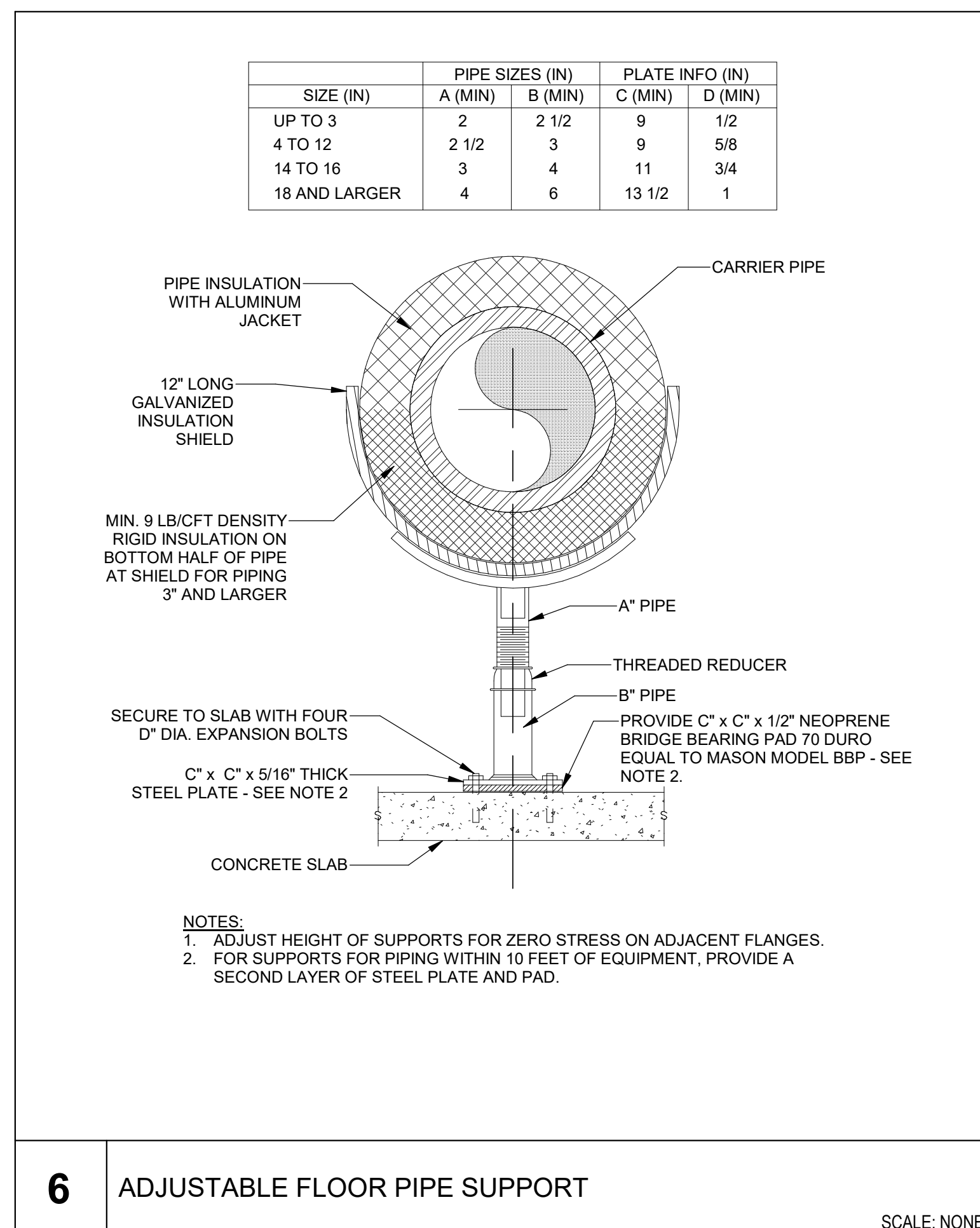
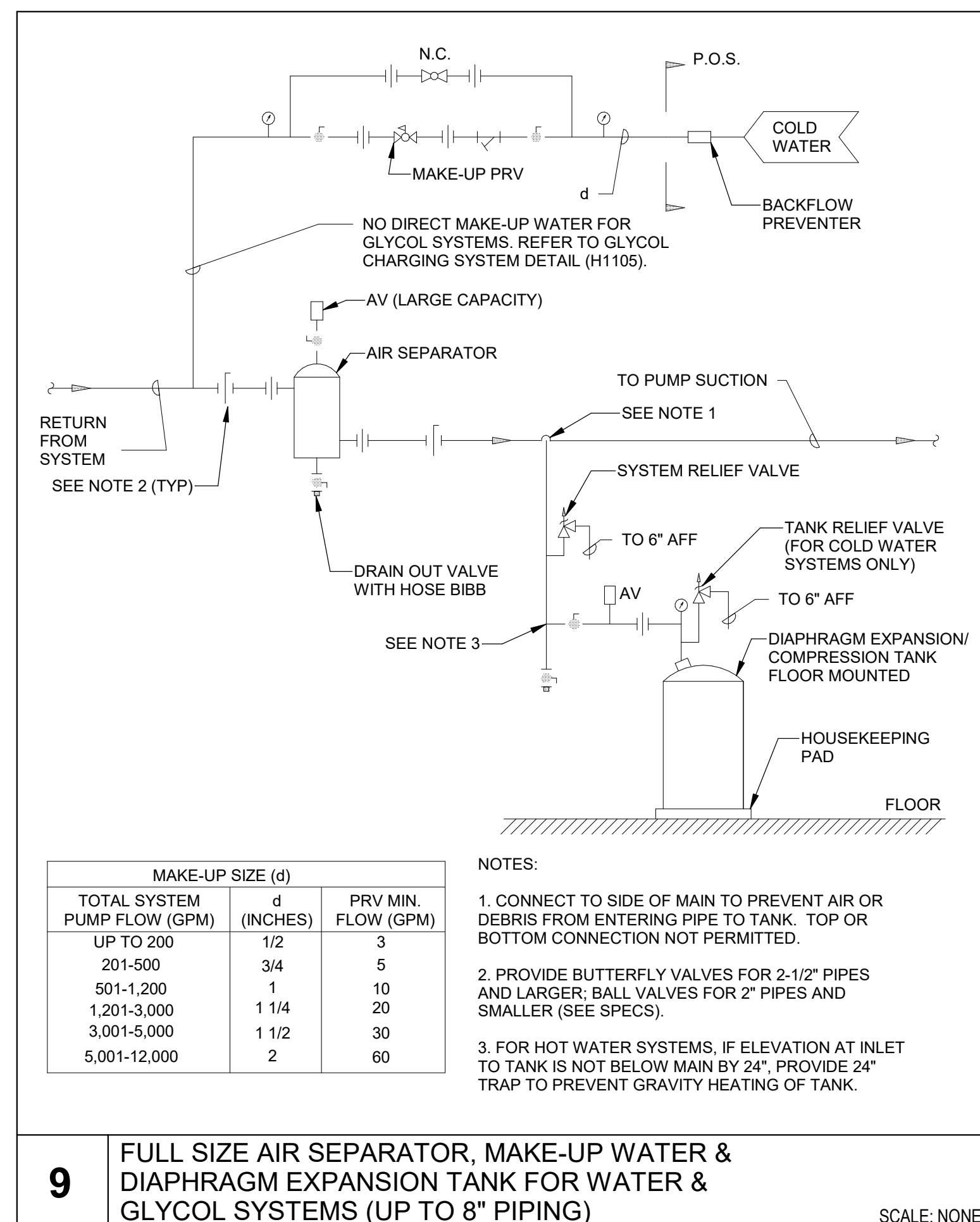
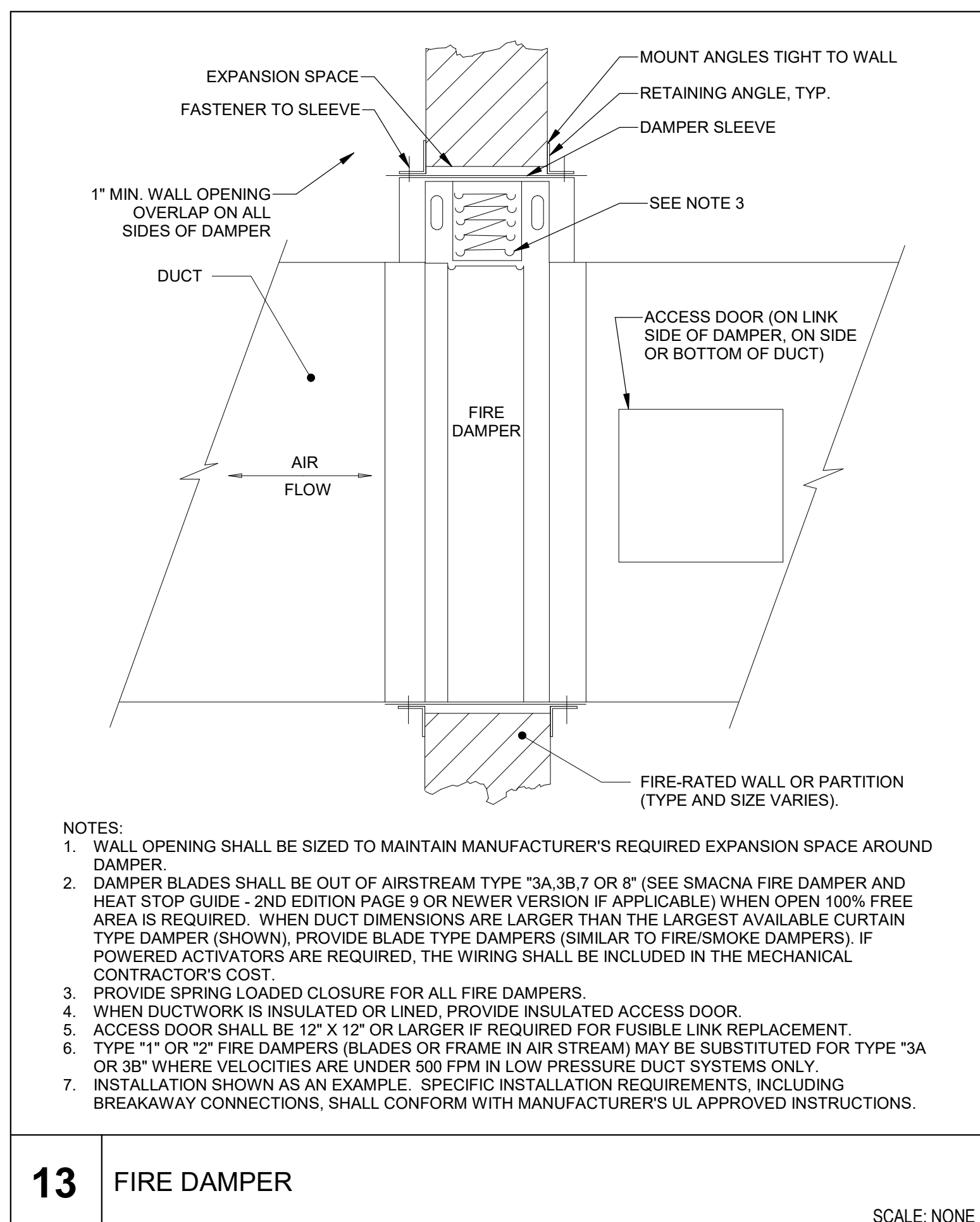
GUC ADMIN
BUILDING HVAC
UPGRADE

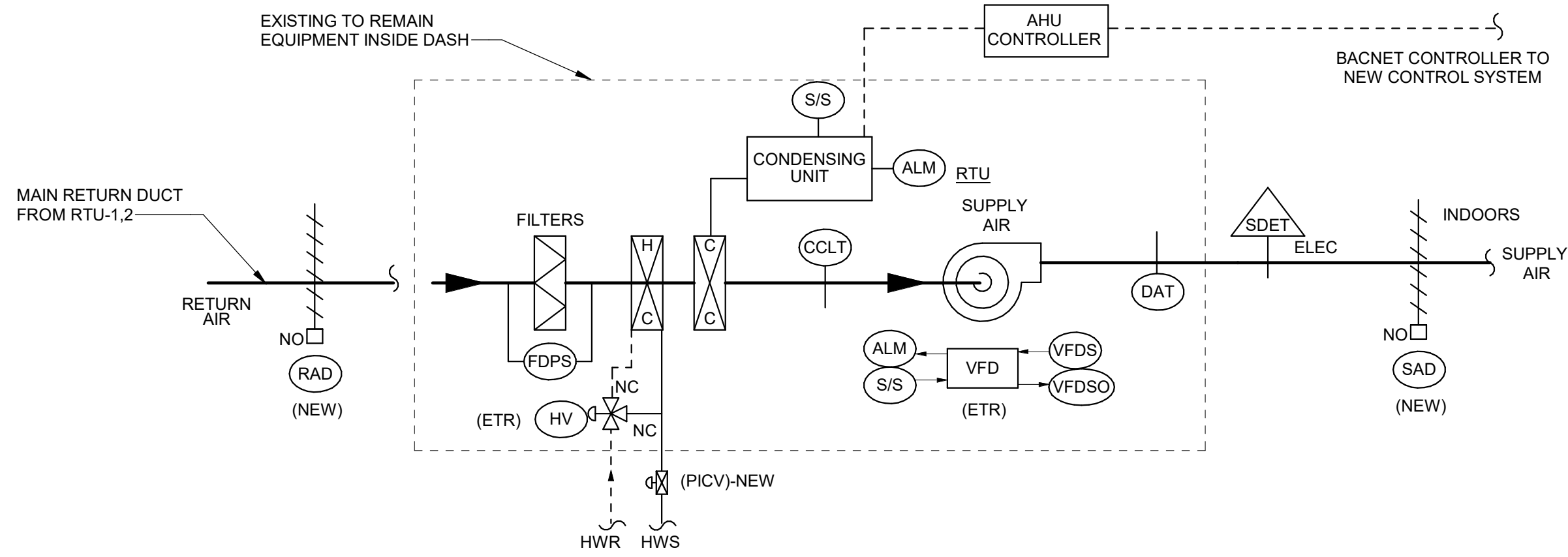
KEY PLAN

REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006-120
DESIGNED BY: IW
CHECKED BY: JUC
DATE: 03/21/2025
SCALE: NTS
SHEET NAME
MECHANICAL
DETAILS
SHEET NUMBER
M501





EXISTING AIR HANDLING UNIT CONTROLS

GENERAL

- EXISTING SEQUENCE OF DESIGN IS EXISTING TO REMAIN EXCEPT WHERE NOTED. EXISTING UNIT CONTROLS SHALL BE MOVED TO NEW BMS SYSTEM. VERIFY TO ENSURE ALL COMPONENTS ARE COMPATIBLE WITH NEW CONTROL VENDOR. REPLACE AS SENSORS ARE REQUIRED FOR A COMPLETE TURNKEY SYSTEM.
- THE CONSTANT VOLUME AIR-HANDLING UNIT CONSISTS OF A PRE-FILTER, DX COOLING COIL, HOT WATER COIL AND SUPPLY FAN. THE UNIT IS DDC CONTROLLED USING ELECTRIC ACTUATION.
- THE AIR-HANDLING UNIT OPERATES IN OCCUPIED, UNOCCUPIED, NIGHT HEATING, NIGHT COOLING AND SAFETY MODES AS FOLLOWS (ALL SUGGESTED SET POINTS AND SETTINGS ARE ADJUSTABLE)
- THE UNIT IS BEING MAINTAINED TO OPERATE AS A BACKUP UNIT. THE SYSTEM SHALL BE NORMALLY DISABLED AT THE USER INTERFACE WHEN OPERATOR ENABLES HEATING WATER VALVE AND CONTROL DAMPERS SHALL OPEN FOR SERVICE AND UNIT SHALL OPERATE AUTOMATICALLY PER EXISTING SEQUENCE OF OPERATION. UPON USER DISABLE SYSTEMS SHALL DE-ENERGIZE, HEATING VALVE SHALL CLOSE, CONTROL DAMPER SHALL CLOSE.

OCCUPIED

- THE SUPPLY FAN STARTS. THE ELECTRIC HEAT AND DX COOLING STAGES IN SEQUENCE WITHOUT OVERLAP TO MAINTAIN THE SUPPLY AIR TEMPERATURE SET POINT. THE SUPPLY AIR TEMPERATURE SET POINT SHALL AUTOMATICALLY BE RESET TO MAINTAIN THE AVERAGE SPACE TEMPERATURE AT THE SPACE TEMPERATURE SET POINT OF 74 DEGREES F (ADJ.)

UNOCCUPIED

- THE SUPPLY FAN IS OFF. THE DX COOLING IS OFF. THE NEW DUCT MOUNTED SUPPLY AND RETURN DAMPERS ARE CLOSED.

NIGHT HEATING

- NIGHT HEATING IS AVAILABLE WHEN THE MINIMUM SPACE TEMPERATURE DROPS BELOW 60 DEGREES F. THE SUPPLY FAN STARTS; THE 3-WAY CONTROL VALVE IS MODULATED TO MAINTAIN SUPPLY AIR TEMPERATURE SET POINT AS DESCRIBED ABOVE AND THE DX COOLING REMAINS OFF.

NIGHT COOLING

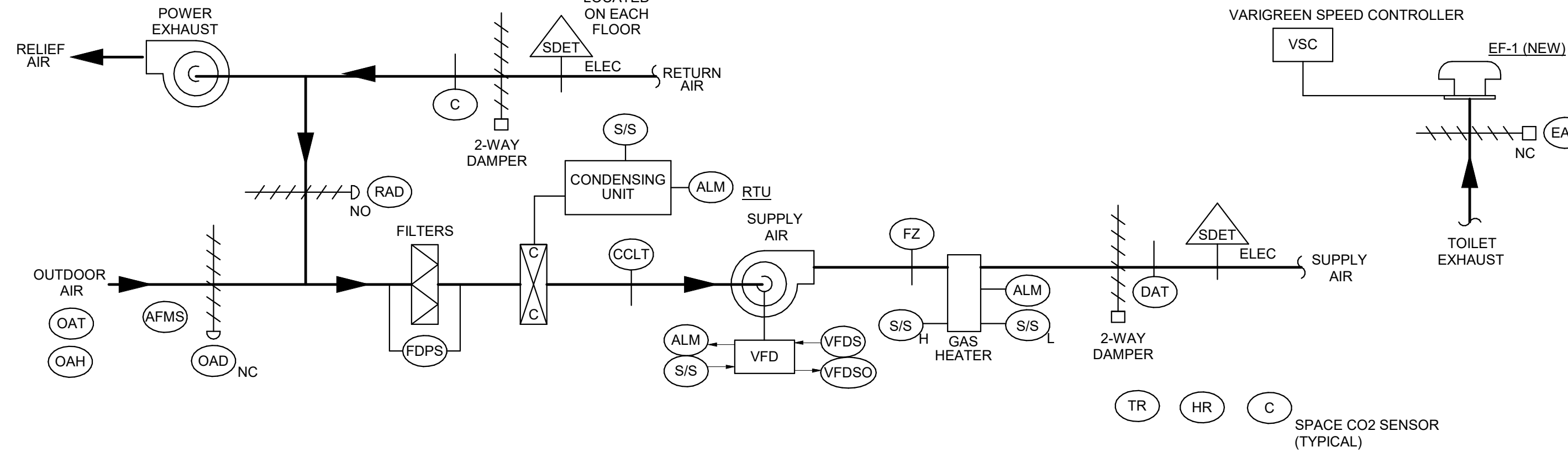
- NIGHT COOLING IS AVAILABLE WHEN THE MAXIMUM SPACE TEMPERATURE RISES ABOVE 80 DEGREES F. THE SUPPLY FAN STARTS THE DX COOLING STAGE TO MAINTAIN SUPPLY AIR TEMPERATURE SET POINT AS DESCRIBED ABOVE AND HEATING HOT WATER VALVE REMAINS OFF.

SAFETIES

- THE NEW SMOKE DETECTOR IN THE SUPPLY AIR STREAM DE-ENERGIZES THE SUPPLY FAN UPON ACTIVATION.
- A CURRENT SWITCH IS INSTALLED IN THE SUPPLY FAN STARTER. THE DDC SYSTEM USES THIS SWITCH TO CONFIRM THE FAN IS IN THE DESIRED STATE (I.E. ON OR OFF) AND GENERATES AN ALARM IF STATUS DEVIATES FROM DDC START/STOP CONTROL.
- NEW BAS TO MONITOR ALARM POINTS

2 EXISTING AHU-1 CONTROLS

SCALE: NONE



ROOFTOP UNIT CONTROL SEQUENCES

GENERAL

- ROOFTOP UNIT AND EXHAUST FAN SHALL BE STARTED AND STOPPED VIA DDC CONTROLLER. COORDINATE OCCUPIED AND UNOCCUPIED SCHEDULES WITH OWNER. ALL SETPOINTS SHALL BE ADJUSTABLE. ALL ACTUATORS SHALL BE ELECTRONIC.
- LOCAL HAND-OFF-AUTOMATIC SWITCH (H-O-A) FOR FANS SHALL OVERRIDE DDC START/STOP (S/S) COMMANDS. ALL HARDWIRED SAFETIES SHALL BE ACTIVE IN BOTH 'Y' AND 'A' POSITIONS.
- ALL TEMPERATURES LISTED ARE FAHRENHEIT.
- ALL TEMPERATURE SENSORS IN THE UNIT AND DUCTWORK SHALL BE AVERAGING TYPE EXCEPT FOR FREEZESTATS WHICH SHALL BE LOW POINT READING TYPE.
- PROVIDE APPROPRIATE ANTI-RECYCLE TIME DELAYS AND SAFETIES ON COMPRESSOR AND GAS HEATER STAGING.
- RTU-1 & 2 SHALL BE STAGED TOGETHER AND RAMPED EQUALLY TO MAINTAIN OPERATING CONDITIONS. IN THE EVENT ONLY ONE UNIT IS UTILIZED THE DUCT MOUNTED SUPPLY AND RETURN CONTROL DAMPERS SHALL BE CLOSED IN THE INOPERABLE UNIT.

FAN CONTROL

- WHILE IN UNOCCUPIED MODE (OR OFF ON SAFETY OR MANUAL DISCONNECT) THE SUPPLY AND EXHAUST FAN (EF) SHALL BE OFF WITH THE OUTSIDE AIR DAMPER (OAD), SUPPLY & RETURN DAMPER, AND EXHAUST AIR DAMPER (EAD) CLOSED.
- WHEN STARTED IN OCCUPIED MODE, THE SUPPLY FAN SHALL START IN RECIRCULATION MODE. THEN THE OAD, AND DUCT MOUNTED SUPPLY & RETURN DAMPER, AND EXHAUST AIR DAMPER, OAD DAMPER SHALL OPEN TO THE MINIMUM OUTDOOR AIR POSITION AS CONTROLLED BY AIR FLOW MONITORING STATION (AFMS - SEE CO2 CONTROL), THE EAD SHALL OPEN, AND THE EXHAUST FAN (EF) SHALL START.
- THE SUPPLY FAN VFD SHALL SLOWLY INCREASE IN SPEED TO MAINTAIN SETPOINT OF REMOTE DIFFERENTIAL PRESSURE SENSOR (DPT). THE DPT SENSOR SHALL BE INSTALLED IN THE SUPPLY DUCTWORK BEFORE IT SPLITS TO SERVE DIFFERENT AREAS. DUCTWORK INITIAL SETPOINT SHALL BE 1.0" W.G. WITH A FINAL SETPOINT DETERMINED BY THE BALANCING CONTRACTOR TO BE AS LOW AS NEEDED TO PROVIDE FULL AIRFLOW TO THE MOST REMOTE TERMINAL BOXES WITH THEIR PRIMARY AIR DAMPERS AT LEAST 50% OPEN.
- AFTER STARTUP, ONCE FAN OPERATION IS STABLE AND THE UNIT IS IN OCCUPIED OF OFF-HOURS UNOCCUPIED OVERRIDE MODE, THE OAD AND THE RAD SHALL SLOWLY OPEN TO MINIMUM OUTDOOR AIR POSITION AS CONTROLLED BY THE OUTDOOR AIR AFMS.

OCCUPIED CARBON DIOXIDE CONTROL

- THE ACTUAL MINIMUM OUTDOOR AIRFLOW SHALL VARY BETWEEN 40% AND 100% OF THE SCHEDULED MINIMUM OUTDOOR AIR VOLUME. NORMAL MINIMUM OUTDOOR AIR (OA) QUANTITY SHALL BE CONTROLLED BY THE OUTDOOR AIR AFMS TO 40% OF THE SCHEDULED MINIMUM OA. IF EITHER OF THE FOLLOWING OCCURS, THE OUTDOOR AIR AFMS SHALL SLOWLY MODULATE THE OAD AND RAD AS REQUIRED TO MAINTAIN THE MAXIMUM CO2 WITHIN 50 PPM OF THE LISTED LIMIT:
 - IF ANY VARIABLE OCCUPANCY SPACE CO2 SENSOR SERVED BY THE UNIT RISES ABOVE THE LIMIT OF 1200 PPM FOR 5 MINUTES.
 - IF THE RETURN AIR CO2 LEVEL AT SENSOR (C) RISES ABOVE LIMIT OF 1000 PPM.

OCCUPIED HEATING CONTROL

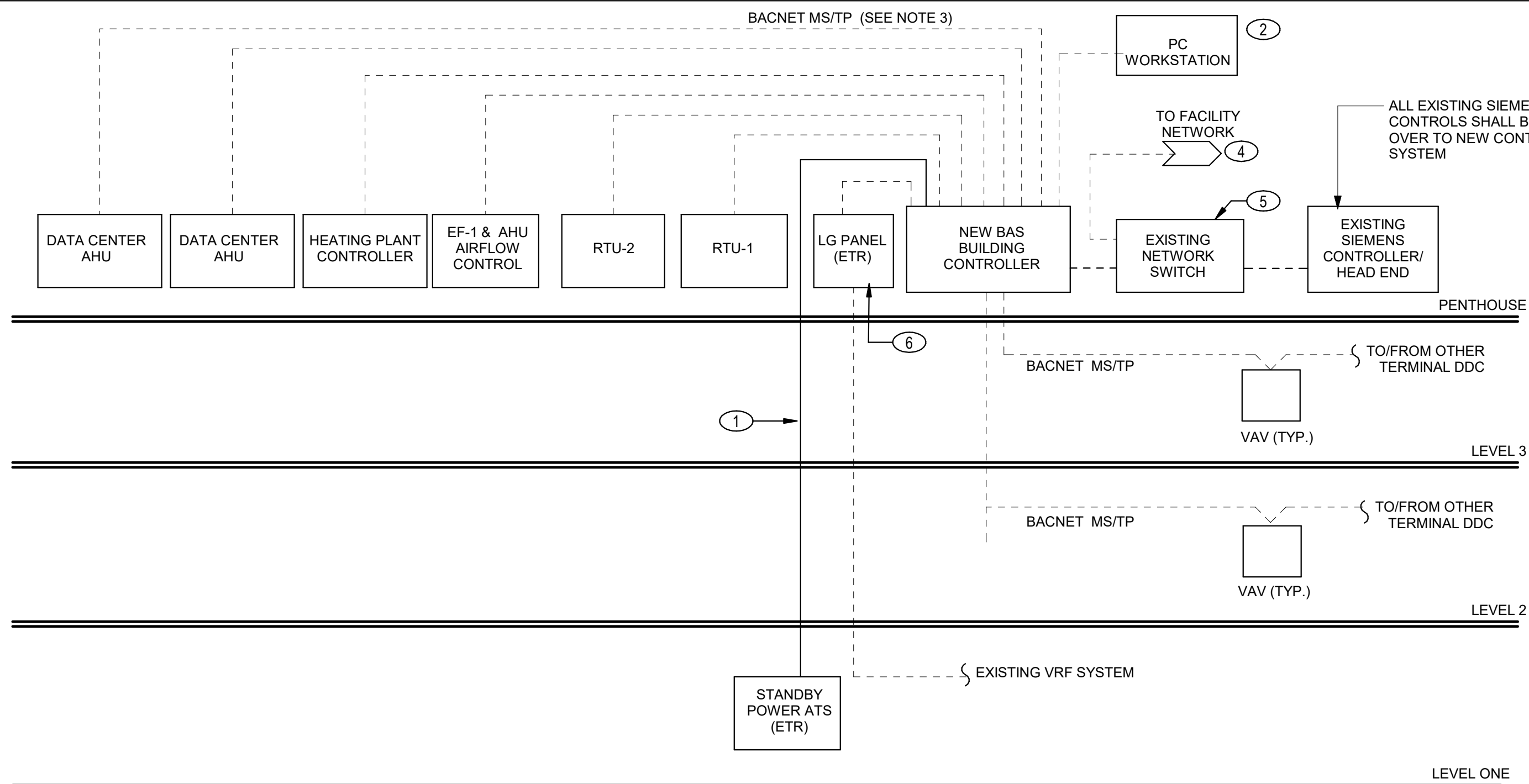
- UPON A DROP IN ROOM TEMPERATURE BELOW THE ROOM HEATING SETPOINT OF 70°F, GAS HEATER SHALL BE STAGED TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. THE REVERSE SHALL OCCUR ON A RISE IN SPACE TEMPERATURE.
- DISCHARGE AIR TEMPERATURE SENSOR DAT SHALL STAGE THE GAS HEATER TO MAINTAIN A MINIMUM TEMPERATURE OF 50°F DURING THE HEATING SEASON.

UNOCCUPIED CONTROL

- IF, WHEN THE UNIT IS OFF, THE ROOM TEMPERATURE FALLS BELOW 56°F, THE UNIT SHALL START WITH RAD OPEN AND OAD CLOSED AND GAS HEATER SHALL BE CONTROLLED BY DAT TO SUPPLY 90°F AIR. WHEN ROOM TEMPERATURE RISES ABOVE 60°F, THE UNIT SHALL SHUT DOWN. EF SHALL REMAIN OFF WITH EAD CLOSED.
- BUTTON ON TR SHALL ALLOW 2-HOUR OVERRIDE FROM UNOCCUPIED TO OCCUPIED CONTROL.

1 RTU-1 & 2 CONTROL SEQUENCE

SCALE: NONE

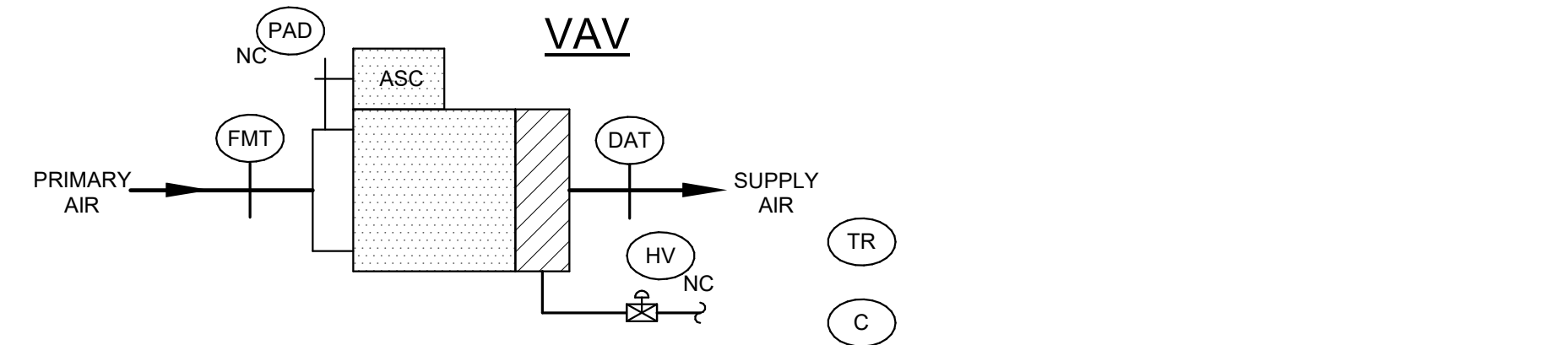


NOTES:

- GENERAL: CONTROLS CONTRACTOR SHALL PROVIDE NEW BAS FOR ALL NEW AND EXISTING EQUIPMENT. EXISTING BAS SHALL BE MIGRATED TO NEW BAS BASED ON CONSTRUCTION PHASING. REFER TO SPECIFICATION 230520 FOR PROJECT REQUIREMENTS.
- EXISTING STANDBY POWER ATS NORMAL/STANDBY MONITORING POINT IS TO BE MIGRATED FROM EXISTING SIEMENS BAS IO TO NEW BAS. CONTRACTOR SHALL PROVIDE ALL NECESSARY UPGRADES TO RELOCATE MONITORING POINT FROM EXISTING SIEMENS PANEL TO NEW BAS PANEL.
- PROVIDE NEW PC WORKSTATION
- PROTOCOLS SHOWN ARE FROM BASIS OF DESIGN. CONTRACTOR SHALL CONFIRM PROTOCOLS FOR EXISTING EQUIPMENT AND PROVIDE INTEGRATION WITH ALL NECESSARY COMMUNICATION PROTOCOL TRANSLATION DEVICES.
- CONTROLS CONTRACTOR SHALL PROVIDE INTEGRATION TO OWNER'S EXISTING FACILITY BUILDING MANAGEMENT SYSTEM. CONTRACTOR SHALL COORDINATE WITH OWNER FOR COMPLETE INTEGRATION TO GREENVILLE UTILITIES OPERATIONS CENTER JCI HEAD END.
- COORDINATE WITH OWNER IT NETWORK TEAM FOR ACCESS TO EXISTING NETWORK CONNECTION CURRENTLY SERVING BUILDING BAS. COORDINATE ALL SECURITY PROTOCOLS FOR REMOTE ACCESS AND NOTIFICATION ALERTING (EMAIL/TEXT ETC.).
- CONTROL CONTRACTOR SHALL INTEGRATE EXISTING LG VRF HEAD END TO BAS FOR REMOTE ACCESS AND MONITORING. ASSUME BACNET INTERFACE IS AVAILABLE. OWNER SHALL PROVIDE ANY PROPRIETARY LG COMMUNICATION HARDWARE UPGRADES IF REQUIRED.
- EXISTING SIEMENS BAS SHALL REMAIN ACTIVE UNTIL COMPLETE INSTALLATION, MIGRATION AND STARTUP IS COMPLETE TO ENSURE BUILDING REMAINS FUNCTIONAL THROUGH PHASED/OCCUPIED CONSTRUCTION. REMOVE ALL SIEMENS HARDWARE AT COMPLETION OF WORK.

4 BAS ARCHITECTURE

SCALE: NONE



VAV BOX WITH HW COIL CONTROL SEQUENCES

GENERAL

- VAV BOX SHALL BE CONTROLLED BY AN APPLICATION SPECIFIC CONTROLLER (ASC). COORDINATE OCCUPIED/UNOCCUPIED SCHEDULES WITH OWNER. ALL SETPOINTS SHALL BE ADJUSTABLE. ALL ACTUATORS SHALL BE ELECTRONIC.
- ALL TEMPERATURES LISTED ARE FAHRENHEIT AND SHALL BE ADJUSTABLE.
- AIRFLOW SHALL BE MEASURED BY THE FLOW MEASURING TRANSMITTER (FMT) AND DISPLAYED ON THE GRAPHICS.
- OCCUPIED HEATING SETPOINT SHALL BE 70°F. OCCUPIED COOLING SETPOINT SHALL BE 5°F WARMER THAN HEATING SETPOINT.
- ROOM TEMPERATURES SHALL BE SET BY THE BUILDING AUTOMATION SYSTEM (BAS) AND CAPABLE OF LOCAL +/- 2°F ADJUSTMENT.
- MINIMUM AND MAXIMUM PRIMARY AIRFLOWS ARE SHOWN ON DRAWINGS.

OCCUPIED HEATING CONTROL

- UPON A CALL FOR HEATING FROM THE ROOM TEMPERATURE SENSOR (TR), THE PAD SHALL MODULATE TO ITS MINIMUM AIRFLOW AND THE HEATING CONTROL VALVE (HV) SHALL MODULATE AS REQUIRED TO MAINTAIN THE HEATING SETPOINT. THE REVERSE SHALL OCCUR ON A RISE IN SPACE TEMPERATURE.

OCCUPIED COOLING CONTROL

- UPON A CALL FOR COOLING FROM THE ROOM TEMPERATURE SENSOR (TR), THE PAD SHALL MODULATE BETWEEN MINIMUM AIRFLOW AND THE HEATING CONTROL VALVE (HV) SHALL MODULATE AS REQUIRED TO MAINTAIN THE COOLING SETPOINT. THE HEATING CONTROL VALVE (HV) SHALL BE CLOSED.

OCCUPIED CO2 CONTROL

- WHEN CO2 LEVEL AT SENSOR (C) RISES ABOVE 1150 PPM THE CONTROLLER SHALL OVERRIDE THE COOLING SIGNAL TO THE PAD TO INCREASE PRIMARY AIR (UP TO MAXIMUM AIRFLOW) AS REQUIRED TO MAINTAIN THE CO2 LEVEL AT 1150 PPM.
- IF THE PAD IS AT MAXIMUM AIRFLOW AND THE CO2 LEVEL RISES ABOVE 1200 PPM FOR 5 MINUTES, THEN THE OW DAMPER ON THE ASSOCIATED INTERLOCKED AIR HANDLER SHALL MODULATE TO PROVIDE MORE OA AS REQUIRED TO MAINTAIN A MAXIMUM ROOM CO2 LEVEL OF 1200 PPM. THIS SEQUENCE SHALL BE REVERSIBLE. THE DDC SYSTEM SHALL GIVE A DETAILED SIGNAL TO THE FRONT END INDICATING THAT THIS OVERRIDE HAS OCCURRED.

UNOCCUPIED HEATING CONTROL

- IF, WHEN THE UNIT IS OFF, THE ROOM TEMPERATURE FALLS BELOW 56°F, THE ASSOCIATED AIR HANDLER SHALL START IN UNOCCUPIED MODE. ALL VAV BOXES SHALL OPEN TO MINIMUM AIRFLOW AND ALL HEATING CONTROL VALVES (HV) SHALL MODULATE TO MAINTAIN A DISCHARGE AIR TEMPERATURE (DAT) OF 90°F. WHEN EACH ROOM TEMPERATURE RISES ABOVE 60°F, THE ASSOCIATED BOX HV SHALL MODULATE TO MAINTAIN 60°F UNTIL ALL ROOMS REACH 60°F, THEN THE BOXES AND ASSOCIATED AIR HANDLER SHALL SHUT DOWN.
- THERE SHALL BE NO UNOCCUPIED COOLING.

UNOCCUPIED OVERRIDE

- BUTTON ON TR SHALL ALLOW 2-HOUR (ADJ.) OVERRIDE FROM UNOCCUPIED TO OCCUPIED CONTROL. WHEN ANY ROOM IS IN THIS OVERRIDE, THE DDC SYSTEM SHALL ENSURE THAT ENOUGH 'UNOCCUPIED' ZONES ARE ALSO OVERRIDDEN SO THAT THE ASSOCIATED AIR HANDLER CAN OPERATE AT MINIMUM AIRFLOW IN THIS MODE.

WARM-UP CONTROL

- PROVIDE OPTIMUM START CAPABILITY. IF ROOM TEMPERATURE IS BELOW 65°F, WARM-UP SHALL BE DONE WITH PAD OPEN TO MINIMUM AIRFLOW AND HEATING CONTROL VALVE (HV) MODULATING TO MAINTAIN A DISCHARGE AIR TEMPERATURE (DAT) OF 90°F. WHEN ALL ROOM TEMPERATURES RISE ABOVE 69°F, OCCUPIED MODE SHALL START.

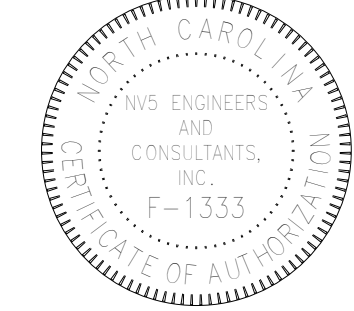
ALARMS

- IF, DURING OCCUPIED MODE, THE ROOM TEMPERATURE SENSOR TR SENSES A TEMPERATURE MORE THAN 5°F ABOVE OR BELOW THE SETPOINT FOR 5 MINUTES, OR BELOW 50°F DURING UNOCCUPIED CONTROL, THE DDC SYSTEM SHALL GIVE A DETAILED ROOM 'HIGH' OR 'LOW' TEMPERATURE ALARM SIGNAL.

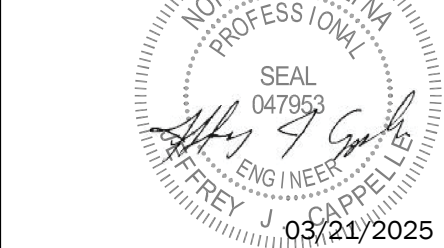
3 VARIABLE AIR VOLUME BOX WITH HOT WATER HEATING CONTROL SEQUENCES

SCALE: NONE

STAMP



CLIENT



CONSULTANT

PROJECT NAME

KEY PLAN

REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.:

DESIGNED BY:

CHECKED BY:

DATE:

SCALE:

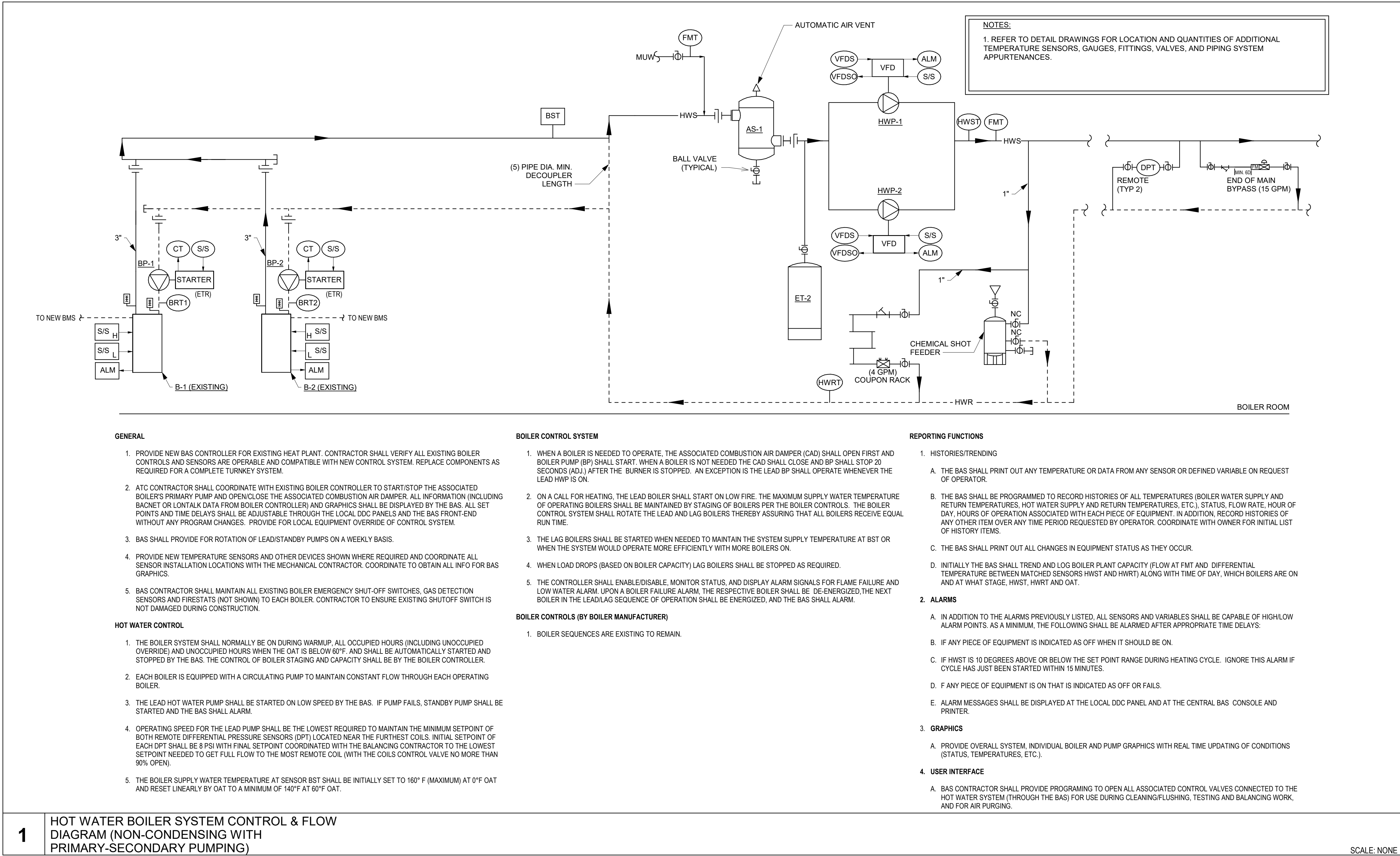
SHEET NAME

MECHANICAL CONTROLS

SHEET NUMBER

M601

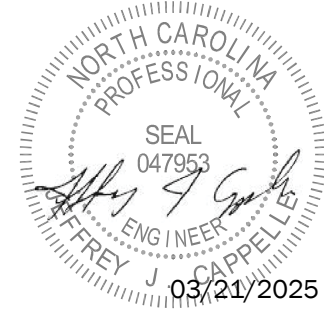
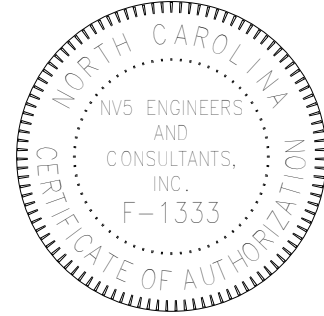
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N|V|5

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CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN BUILDING HVAC UPGRADE

KEY PLAN



REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120

DESIGNED BY: IW

CHECKED BY: JUC

DATE: 03/21/2025

SCALE: 1/8" = 1'-0"

SHEET NAME

MECHANICAL CONTROLS

SHEET NUMBER

M602

4'-0" 8'-0" 16'-0"

PACKAGED DX ROOFTOP AIR HANDLING UNIT SCHEDULE (OWNER PRE-PURCHASED-SHOWN FOR REFERENCE ONLY)																																										
TAG	SERVICE	LOCATION	UNIT SIZE (TON)	REFRIGERANT	SUPPLY FAN										GAS HEAT				UNIT COOLING COIL				HOT GAS REHEAT		COMPRESSOR(S)		CONDENSER FAN				ELECTRICAL SERVICE				FILTER	EER	MANUFACTURER AND MODEL (AS BASIS OF DESIGN)	REMARKS				
					CFM			FAN QTY	ESP (IN. WG)	DRIVE	MOTOR					OUTPUT CAPACITY (MBH)	INPUT	EAT	LAT	TURNDOWN	GROSS CAPACITY (MBH)		COIL EAT °F		COIL LAT °F		UNIT EAT	UNIT LAT	TYPE	NO.	AMBIENT AIR DB TEMP (°F)	NO.	HP EA	MCA					MOCp	HZ	V	PH
					TOTAL	MIN. O.A.	TYPE				RPM	BHP	HP	V	PH						TOTAL	SENS.	DB	WB	DB	WB																
RTU-1	2ND/3RD FLOORS	ROOF	25	R-32	9,000	1,500	VAV	1	2.5	DIRECT	1,695	9.02	10	460	3	243	300	45	70.3	4 STAGES	380.2	246.5	80	67	56	54.6	56	75	SCROLL	2	95	2	---	83.5	100	60	460	3	2" MERV 8 AND 13	10	DAIKIN- DPSC31B	BELOW
RTU-2	2ND/3RD FLOORS	ROOF	25	R-32	9,000	1,500	VAV	1	2.5	DIRECT	1,695	9.02	10	460	3	243	300	45	70.3	4 STAGES	380.2	246.5	80	67	56	54.6	56	75	SCROLL	2	95	2	---	83.5	100	60	460	3	2" MERV 8 AND 13	10	DAIKIN- DPSC31B	BELOW

NOTES:

1. REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DRAWINGS FOR ADDITIONAL INFORMATION.

2. MAXIMUM TEMPERATURE OF AIR LEAVING UNIT, NOT COIL (MUST INCLUDE HEAT FROM FAN MOTORS).

3. PROVIDE A WEATHERPROOF GFI CONVENIENCE OUTLET. RECEPTACLE SHALL BE POWERED THROUGH UNIT.

4. SLOPED STAINLESS STEEL EVAPORATOR COIL DRAIN PAN.

5. FACTORY DISCONNECT AND CIRCUIT BREAKER

6. PROVIDE ECONOMIZER; FACTORY INSTALLED POWER EXHAUST

7. PROVIDE HOT GAS REHEAT

NATURAL GAS LOAD SUMMARY		
TAG	GAS LOAD (CFH)	GAS PRESSURE AT UNIT (IN. W.C.)
GENERATOR (E)	2,802	
QAU-1 (E)	150	11"
BOILERS (QTY. 2) (E)	798	7"
RTU-1	243	14"
RTU-2	243	14"
TOTALS:	4,236	

OUTSIDE AIR SUMMARY- SECOND FLOOR							
PLAN AREA/ ROOM/ ZONE	CFM/ PERSON (Rp)	NUMBER OF PEOPLE (Pz)	CFM/ SQFT (Ra)	SQFT (Az)	AIR DISTRIBUTION EFFECTIVENESS (EZ)	QTY. OF ROOMS	ZONE OA CFM (Voz)
VAV-2-1	5	5	0.06	588	0.80	1	75
VAV-2-2	5	2	0.06	345	0.80	1	38
VAV-2-3	5	2	0.06	428	0.80	1	45
VAV-2-4	5	1	0.06	248	0.80	1	25
VAV-2-5	5	2	0.06	395	0.80	1	42
VAV-2-6	5	1	0.06	425	0.80	1	38
VAV-2-7	5	2	0.06	603	0.80	1	58
VAV-2-8	5	10	0.06	220	0.80	1	79
VAV-2-9	5	1	0.06	210	0.80	1	22
VAV-2-10	5	1	0.06	212	0.80	1	22
VAV-2-11	5	1	0.06	156	0.80	1	18
VAV-2-12	5	1	0.06	590	0.80	1	51
VAV-2-13	5	8	0.06	155	0.80	1	62
VAV-2-14	5	4	0.06	577	0.80	1	68
VAV-2-15	5	3	0.06	775	0.80	1	77
VAV-2-16	5	8	0.06	140	0.80	1	61
VAV-2-17	5	6	0.06	883	0.80	1	104
VAV-2-18	5	2	0.06	757	0.80	1	69
VAV-2-19	5	55	0.06	426	0.80	1	426
VAV-2-20	5	3	0.06	599	0.80	1	64
VAV-2-21	5	2	0.06	479	0.80	1	48
VAV-2-22	5	1	0.06	212	0.80	1	22
VAV-3-1	5	1	0.06	244	0.80	1	25
VAV-3-2	5	2	0.06	373	0.80	1	40
VAV-3-3	5	3	0.06	513	0.80	1	57
VAV-3-4	5	1	0.06	280	0.80	1	27
VAV-3-5	5	2	0.06	443	0.80	1	46
VAV-3-6	5	2	0.06	419	0.80	1	44
VAV-3-7	5	10	0.06	219	0.80	1	79
VAV-3-8	5	4	0.06	720	0.80	1	79
VAV-3-9	5	1	0.06	420	0.80	1	38
VAV-3-10	5	1	0.06	663	0.80	1	56
VAV-3-11	5	2	0.06	324	0.80	1	37
VAV-3-12	5	4	0.06	616	0.80	1	71
VAV-3-13	5	8	0.06	1,588	0.80	1	169
VAV-3-14	5	5	0.06	630	0.80	1	79
VAV-3-15	5	18	0.06	369	0.80	1	140
VAV-3-16	5	5	0.06	566	0.80	1	74
VAV-3-17	5	5	0.06	600	0.80	1	76
VAV-3-18	5	5	0.06	891	0.80	1	98
VAV-3-19	5	1	0.06	330	0.80	1	31
VAV-3-20	5	24	0.06	470	0.80	1	185
VAV-3-21	5	2	0.06	285	0.80	1	34
				SYSTEM UNCORRECTED OUTDOOR AIR INTAKE (Vou)			2,398
				SYSTEM VENTILATION EFFICIENCY (Ev)			0.800
				SYSTEM TOTAL CORRECTED RTU O/A REQUIRED (Vot)			3,000

AIR & DIRT SEPARATOR SCHEDULE								
TAG	SERVICE	LOCATION	WATER FLOW GPM	PIPE SIZE (IN)	PD FT. HD.	FLOOD WEIGHT (LBS)	MANUFACTURER AND MODEL NUMBER (AS STANDARD)	REMARKS
AS-1	HOT WATER	PENTHOUSE	60	2.5	0.6	355	SPIROTHERM - VDN 250	BELOW

1. DEVICE MUST BE A HIGH EFFICIENCY COALESCING AIR & DIRT SEPARATOR

DUCTWORK PRESSURE CLASS AND SEAL CLASS					
PRESSURE CLASS	STATIC PRESSURE RATING	SMACNA SEAL CLASS	SMACNA LEAKAGE CLASS		DESIGN VELOCITY LIMITS
			RECTANGULAR	ROUND	
2"	2" POS. OR NEG.	A	6	3	2000 FPM OR LESS
4"	4" POS. OR NEG.	A	6	3	2000 FPM OR LESS
UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS, USE THE FOLLOWING PRESSURE CLASSIFICATIONS FOR THE TYPES OF DUCTWORK LISTED BELOW.					
4" (POS) CLASS:	ALL SUPPLY DUCTWORK BETWEEN THE DISCHARGE OF AIR SUPPLY UNITS TO THE INLETS OF SUPPLY TERMINAL VOLUME BOXES.				
2" CLASS:	ALL OTHER DUCTWORK.				
NOTES:					
1. CONTRACTOR SHALL LEAK TEST (SUBMIT REPORT) A MINIMUM OF 100% OF THE SURFACE AREA FOR ALL DUCTWORK ABOVE PRESSURE CLASS 3".					
2. FOR NEGATIVE PRESSURE OVER 3" W.G. REFER TO SMACNA ROUND AND RECTANGULAR INDUSTRIAL DUCT CONSTRUCTION STANDARDS FOR JOINT AND INTERMEDIATE CONNECTION DETAIL REQUIREMENTS.					
3. FOR NEGATIVE DUCTWORK, NEGATIVE PRESSURE OVER 2" W.G. REFER TO SMACNA ROUND INDUSTRIAL DUCT CONSTRUCTION STANDARDS AND BUILD TO NEGATIVE RATING SPECIFIED (4" W.G. MIN.).					
4. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION.					

MINIMUM DUCT INSULATION R-VALUES					
LOCATION	SUPPLY	RETURN	RAW OUTDOOR AIR	EXHAUST	
				ENERGY RECOVERY	NO ENERGY RECOVERY
UNCONDITIONED SPACE (SHAFT OR CEILING WITH DUCTED RETURN AIR)	R-6	R-6	R-6	R-6	-0-
RETURN AIR PLENUM	R-4	-0-	R-6	-0-	-0-
EXPOSED IN ZONE SERVED	R-6	-0-	R-6	R-6	-0-

NOTES: (SEE SPECIFICATIONS FOR R-VALUES OF VARIOUS DUCT INSULATION AND LINERS).

1. R-VALUES SHOWN MAY BE OBTAINED BY ADDING THE R-VALUES OF BOTH THE LINING (WHERE SHOWN OR USED) AND EXTERNAL DUCT INSULATION.
2. R-VALUES SHOWN ARE INSTALLED. USE R-VALUES FOR 25% COMPRESSION FOR NON-RIGID INSULATION.
3. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION.

2ND FLOOR TERMINAL VOLUME BOX SCHEDULE																					
TAG	CONTROL MOUNT SIDE	INLET SIZE	GPM		STATIC PRESSURE				NO LEVELS				HOT WATER COIL DATA							BASIC OF DESIGN MANUFACTURER AND MODEL NUMBER	REMARKS
			MAX	MIN	INLET	DOWN	MIN	MIN	RAD.	DISCH.	HEATING GPM	MBH	EWT	LWT	GPM	P.D.	ROWS	EAT	LAT		
VAV-2-1	R	8	650	195	1	0.25	0.01	15	20	330	20	140	120	1.2	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-2	R	6	400	120	1	0.25	0.01	15	20	320	12	140	120	1.2	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-3	R	6	400	120	1	0.25	0.01	15	20	320	12	140	120	1.2	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-4	R	6	350	105	1	0.25	0.01	15	20	300	12	140	120	1.2	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-5	R	6	450	135	1	0.25	0.01	15	20	330	12	140	120	1.2	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-6	L	8	550	165	1	0.25	0.01	15	20	400	18	140	120	1.8	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-7	R	6	600	180	1	0.25	0.01	15	20	400	15	140	120	1.5	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-8	L	6	400	120	1	0.25	0.01	15	20	160	6	140	120	0.6	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-9	L	6	250	75	1	0.25	0.01	15	20	160	6	140	120	0.6	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-10	R	6	300	90	1	0.25	0.01	15	20	320	12	140	120	1.2	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-11	L	6	200	60	1	0.25	0.01	15	20	160	6	140	120	0.6	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-12	L	6	425	127.5	1	0.25	0.01	15	20	285	10	140	120	1.0	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-13	R	6	200	60	1	0.25	0.01	15	20	160	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-14	R	6	300	90	1	0.25	0.01	15	20	80	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-15	L	8	475	142.5	1	0.25	0.01	15	20	80	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-16	R	6	200	60	1	0.25	0.01	15	20	80	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-17	R	8	500	150	1	0.25	0.01	15	20	120	6	140	120	0.6	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-18	R	6	475	142.5	1	0.25	0.01	15	20	80	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-19	R	10	1200	360	1	0.25	0.01	15	20	530	20	140	120	2.0	1.3	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-20	R	6	400	120	1	0.25	0.01	15	20	160	6	140	120	0.6	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-21	L	6	225	67.5	1	0.25	0.01	15	20	80	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	
VAV-2-22	R	6	225	67.5	1	0.25	0.01	15	20	160	6	140	120	0.6	0.06	2	55	90	NALOR - D30RW	1,2,3,4,5,6	

NOTES:

1. REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DIAGRAMS FOR ADDITIONAL INFORMATION.
2. COIL HEATING CAPACITY SHALL BE BASED ON MINIMUM CFM AND GPM ON DRAWINGS FOR EACH BOX.
3. MINIMUM LEAVING AIR TEMPERATURE (LAT) FOR SUPPLEMENTARY COILS WITH SUPPLEMENTARY HEAT SHALL BE 72 F UNLESS OTHERWISE SCHEDULED.
4. CONTROLS SHALL BE FACTORY MOUNTED BY THE TERMINAL UNIT MANUFACTURER.
5. PROVIDE TOGGLE DISCONNECT SWITCH.
6. PROVIDE 24 VOLT TRANSFORMER.

3RD FLOOR TERMINAL VOLUME BOX SCHEDULE																				
TAG	CONTROL MOUNT SIDE	INLET SIZE	CFM		STATIC PRESSURE			FLOOR LEVELS			HOT WATER COIL DATA							BASIC GP DESIGN MANUFACTURER AND MODEL NUMBER	REMARKS	
			MAX	MIN	INLET	DOWN	MIN	RAD	DISCH	HEATING CFM	MBH	EWT	LWT	GPM	P.D.	ROWS	EAT			LAT
VAV-3-1	R	6	400	120	1	0.25	0.01	15	20	345	13	140	120	1.3	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-2	R	6	400	120	1	0.25	0.01	15	20	345	13	140	120	1.3	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-3	L	8	600	180	1	0.25	0.01	15	20	480	18	140	120	1.8	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-4	L	8	500	150	1	0.25	0.01	15	20	400	15	140	120	1.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-5	R	8	600	180	1	0.25	0.01	15	20	400	15	140	120	1.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-6	L	8	700	210	1	0.25	0.01	15	20	530	20	140	120	2	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-7	R	8	400	120	1	0.25	0.01	15	20	265	10	140	120	1	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-8	L	8	525	158	1	0.25	0.01	15	20	400	15	140	120	1.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-9	L	8	600	180	1	0.25	0.01	15	20	530	20	140	120	2	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-10	R	8	600	180	1	0.25	0.01	15	20	400	15	140	120	1.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-11	R	8	350	105	1	0.25	0.01	15	20	265	10	140	120	1	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-12	R	6	400	120	1	0.25	0.01	15	20	135	5	140	120	0.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-13	R	10	800	240	1	0.25	0.01	15	20	270	10	140	120	1.0	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-14	L	8	500	150	1	0.25	0.01	15	20	135	5	140	120	0.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-15	R	6	500	150	1	0.25	0.01	15	20	135	5	140	120	0.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-16	L	6	400	120	1	0.25	0.01	15	20	135	5	140	120	0.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-17	R	6	400	120	1	0.25	0.01	15	20	135	5	140	120	0.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-18	R	8	600	180	1	0.25	0.01	15	20	135	5	140	120	0.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-19	R	8	200	60	1	0.25	0.01	15	20	80	3	140	120	0.3	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-20	R	8	600	180	1	0.25	0.01	15	20	270	10	140	120	1.0	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6
VAV-3-21	L	8	500	150	1	0.25	0.01	15	20	400	15	140	120	1.5	0.06	2	55	90	NALOR - D30RW	12.3.4.5.6

NOTES:

1. REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DIAGRAMS FOR ADDITIONAL INFORMATION.
2. COIL HEATING CAPACITY SHALL BE BASED ON MINIMUM CFM AND GPM ON DRAWINGS FOR EACH BOX.
3. MINIMUM LEAVE-AIR TEMPERATURE (LAT) FOR REPTOR COILS WITH SUPPLEMENTARY HEAT SHALL BE 72 F UNLESS OTHERWISE SCHEDULED.
4. CONTROLS SHALL BE FACTORY MOUNTED BY THE TERMINAL UNIT MANUFACTURER.
5. PROVIDE TOGGLE DISCONNECT SWITCH.
6. PROVIDE 24 VOLT TRANSFORMER.

FAN SCHEDULE															
TAG	SERVICE	LOCATION	CFM	FAN TYPE	E.S.P. (IN.WG @INLET)	DRIVE	WHEEL		MOTOR					MANUFACTURER AND MODEL NUMBER AS BASIS OF DESIGN	REMARKS
							TYPE	FAN RPM	RPM	BHP	HP	V	PH		
EF-1	FLOORS 1-3	ROOF	4,560	DOWNBLAST	0.75	BELT	CENT.	789	1,725	1.07	1.5	460	3	GREENHECK - GB-220-VFD	BELOW

1. REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DRAWINGS FOR ADDITIONAL INFORMATION.
2. PROVIDE VARIGREEN SPEED CONTROLLER
3. EXHAUST FANS SHALL BE INTEGRATED WITH BMS FOR MONITORING AND CONTROL.
4. UNIT MOUNTED DISCONNECT SWITCH PROVIDED BY ELECTRICAL CONTROLLER.
5. PROVIDE MANUFACTURER CURB WITH MOTORIZED CONTROL DAMPER.

DIAPHRAGM EXPANSION TANK SCHEDULE														
TAG	SERVICE	LOCATION	FLUID	SYSTEM TEMP (°F)		SYSTEM PRESSURE (PSIG) AT TANK		VOLUME (GALLONS)		DIMENSIONS		INITIAL TANK AIR CHARGE (PSIG)	BASIS OF DESIGN MANUFACTURER AND MODEL NUMBER	REMARKS
				MIN	MAX	MIN	MAX	TANK	ACCEPTANCE	DIAMETER	HEIGHT			
ET-1	HOT WATER	PENTHOUSE BOILER RM	HOT WATER	40	180	15	35	23	23	16	37	12	BELL & GOSSETT B-85	BELOW
1. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION														
2. VERTICALLY INSTALLED PRE-CHARGED BLADDER TYPE EXPANSION TANK. MUST BE ASME RATED.														
3. BLADDER SHALL BE REPLACEABLE.														


[illegible]

1. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION AND ARCHITECTURAL RCP FOR CEILING TYPES.
2. BASIS OF DESIGN SHALL BE PRICE EQUALS BY METALAIR, NAILOR, OR TITUS.
3. MANUAL VOLUME DAMPERS TO BE PROVIDED AT ALL TAKEOFFS FOR GRILLES.
4. ALL GRILLES AND DIFFUSERS SHALL BE POWER COAT B12 WHITE.
5. PROVIDE INSULATED SOUND BOOT PER DETAIL.
6. COLOR SELECTION BY ARCHITECT
7. PROVIDE MOLDED BACK PAN INSULATION

PUMP SCHEDULE															
TAG	SERVICE	LOCATION	FLUID			HEAD (FT.)	IMPELLER SIZE (IN.)	MOTOR					BASIS OF DESIGN MANUFACTURER AND MODEL NUMBER	REMARKS	
			TYPE	TEMP.	GPM			RPM	BHP	HP	V	PH			
HWP-1	HWS PUMP	MECH RM.	H20	140	60	5.39	50	8.125	1800	1.38	3	460	3	B&G E-80SC-2X2X9.5C	1.2
HWP-2	HWS PUMP	MECH RM.	H20	140	60	5.39	50	8.125	1800	1.38	3	460	3	B&G E-80SC-2X2X9.5C	1.2

NOTES:

- REFER TO SPECIFICATIONS, DETAILS, AND CONTROL DRAWINGS FOR ADDITIONAL INFORMATION.
- PUMP SHALL BE RATED FOR VFD OPERATION



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CLIENT _____

CLIENT _____

CONSULTANTPROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN

[illegible]

PROJECT NO.:	24-0006120
DESIGNED BY:	IW
CHECKED BY:	JJC
DATE:	03/21/2025
SCALE:	NTS

MECHANICAL SCHEDULES

SHEET NUMBER

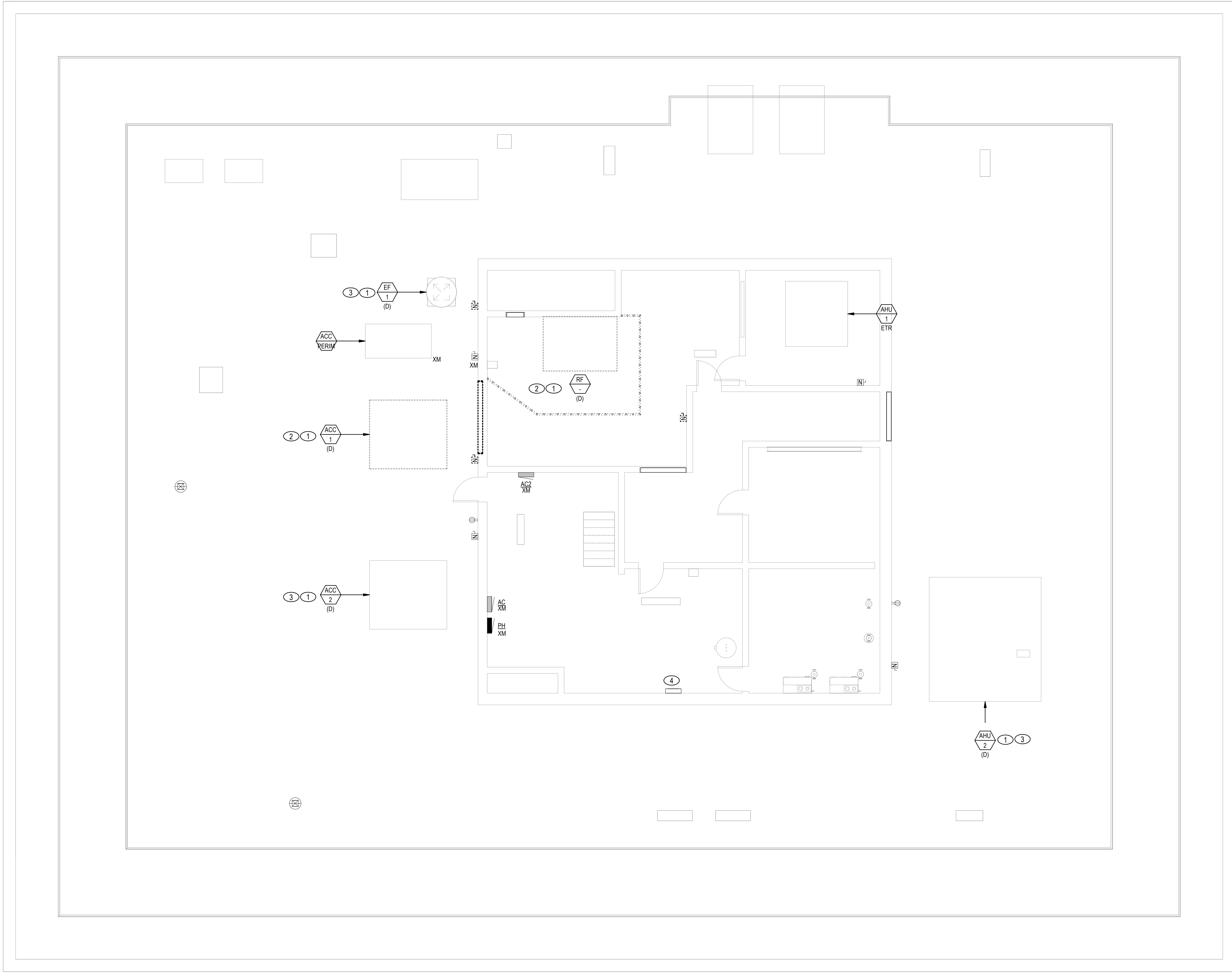
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ELECTRICAL ABBREVIATIONS			
#	NUMBER	L	LOCATION
*18"	MOUNTING HEIGHTS ARE TO CENTERLINE OF DEVICE ABOVE FINISH FLOOR OR FINISH GRADE	LOR	LOOK OUT RELAY
		LTG	LIGHTING
		LV	LOW VOLTAGE
A	AMP	M	EXISTING EQUIPMENT TO BE REWORKED/MODIFIED
AC	AIR CONDITIONING	MTR	MOTOR
ADA	AMERICAN WITH DISABILITIES ACT	MGR	MOTOR/GENERATOR SET
AF	AMPERE FRAME	MAN	MANUAL
AFCI	ARC FAULT CIRCUIT INTERRUPTER	MAX	MAXIMUM
AFB	ABOVE FINISHED FLOOR	MCA	MINIMUM CIRCUIT AMPS
AFO	ABOVE FINISH GRADE	MCB	MAIN CIRCUIT BREAKER
AHJ	AUTHORITY HAVING JURISDICTION	MCC	MOTOR CONTROL CENTER
AHU	AIR HANDLING UNIT	MCP	MOTOR CONTROL PANEL
AIC	AMPERE INTERRUPTING CAPACITY	MCS	MASSACHUSETTS ELECTRICAL CODE
AL	ALUMINUM	MECH	MECHANICAL
APPROX	APPROXIMATE	MFR	MANUFACTURER
ARCH	ARCHITECT	MH	MAINTENANCE HATCH
ATS	AUTOMATIC TRANSFER SWITCH	MIN	MINIMUM
AUTO	AUTOMATIC	MISC	MISCELLANEOUS
AVS	AVERAGE	MLO	MAIN LUGS ONLY
AWG	AMERICAN WIRE GAUGE	MOP	MAXIMUM OVER CURRENT PROTECTION
		MSS	MAIN SWITCHBOARD
B	BURIED	MTD	MOUNTED
BKR	BREAKER	MTG	MOUNTING
BLDG	BUILDING	MTS	MANUAL TRANSFER SWITCH
C	CONDUIT	N	NEW LOCATION OF EXISTING WORK
CA	CABLE	N	NEUTRAL
CAB	CABINET	NA	NOT APPLICABLE
CAT	CATALOG	NC	NORMALLY CLOSED
CATV	CABLE TELEVISION	NEC	NATIONAL ELECTRICAL CODE
CB	CIRCUIT BREAKER	NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
CCTV	CLOSED CIRCUIT TELEVISION	NF	NON-FUSED
CEC	CALIFORNIA ELECTRICAL CODE	NEPA	NATIONAL FIRE PROTECTION ASSOCIATION
CKT	CIRCUIT	NOT IN CONTRACT	
CL	CENTERLINE	NO	NORMALLY OPEN
CLF	CURRENT LIMITING FUSE	NORM	NORMAL
CLG	COLUMN	NRTL	NATIONALLY RECOGNIZED TESTING LABORATORY
COL	COMBINATION	NTS	NOT TO SCALE
CONB	CONNECTION	NVE	NEVADA ENERGY
CONN	CONNECTION		
CONST	CONSTRUCTION	O	ON CENTER
CONTR	CONTRACTOR	OC	OWNER FURNISHED CONTRACTOR INSTALLED
CPU	CENTRAL PROCESSING UNIT	OFI	OVERHEAD
CS	CONTROL SWITCH	OPD	OVER CURRENT PROTECTION DEVICE
CTRL	CONTROL	OSHPD	OFFICE OF STATEWIDE HEALTH PLANNING AND DEVELOPMENT
CU	COPPER		
D	DEMO	P	POLE
DB	DECEMBER	PB	PUSH BUTTON
DB	DISTRIBUTION BOARD	PDU	POWER DISTRIBUTION UNIT
DC	DIRECT CURRENT	PF	POWER FACTOR
DET	DETAIL	PH(0)	PHASE
DIA	DIAMETER	PL	PILOT LIGHT
DISC	DISCONNECT	PNL	PANEL
DIST	DISTRIBUTION	POC	POINT OF CONNECTION
DN	DOWN	POD	POINT OF DISCONNECTION
DWG	DRAWING	PROV	PROVIDED UNDER OTHER SECTIONS
		PP	POWER POLE
		PTZ	PAN, TILT, ZOOM
E	EXIST EXISTING	PVC	POLYVINYL CHLORIDE
EA	EACH	POWER	
EC	ELECTRICAL CONTRACTOR		
EHU	ELECTRIC HEATING UNIT	R	EXISTING WORK TO BE RELOCATED
EL	ELEVATION	(R)	
ELEC	ELECTRICAL	RECEPT	RECEPTACLE
ELR	END OF LINE RESISTOR	REFRIG	REFRIGERATOR
EMERG	EMERGENCY	REQD	REQUIRED
EMT	ELECTRIC METALLIC TUBING	RGS	RIGID GALVANIZED STEEL
ENG	ENGINEER	RM	ROOM
EQUIP	EQUIPMENT	RMS	ROOT MEAN SQUARE VALUE
ERL	EXISTING TO BE RELOCATED	RND	ROUND
ETC	ELAPSED TIME CONTROLLER	RP	REVOLUTIONS PER MINUTE
EW	ELECTRIC WATER HEATER		
F	FIRE ALARM	S	SECOND
FIA	FIRE ALARM ANNUNCIATOR PANEL	SN	SOLID NEUTRAL
FACP	FIRE ALARM CONTROL PANEL	SNEC	SOUTHERN NEVADA ELECTRICAL CODE AMENDMENTS
FDR	FEEDER	SPD	SURGE PROTECTIVE DEVICE
FIKT	FIXTURE	SPEC	SPECIFICATION
FL	FLOOR	SQ	SQUARE
FLA	FULL LOAD AMPS	SQFT	SQUARE FEET
FLMT	FLEXIBLE LIQUID TIGHT METALLIC TUBING	SS	SAFETY SWITCH
FLUOR	FLUORESCENT	STR	SYNC SWITCH
FR	FRAME	STRUCT	STRUCTURAL
FREQ	FREQUENCY	SW	SWITCH
FT	FOOT	SWBD	SWITCHGEAR
		SWGR	SYMMETRICAL
G	GROUND	T	TEMPERATURE
GEC	GROUNDING ELECTRODE CONDUCTOR	T, XFMR	TRANSFORMER
GEN	GENERATOR	TB	TERMINAL BLOCK
GFI, GFCI	GROUND FAULT CIRCUIT INTERRUPTER	TEL	TELEPHONE
GFP	GROUND FAULT PROTECTION	TERM	TERMINAL
H	HANDHOLE	TS	TEMPERATURE SWITCH
HH	HIGH INTENSITY DISCHARGE	TSP	TWISTED SHIELDED-PAIR
HCA	HAND OFF AUTOMATIC	TT	THERMAL SWITCH
HORZ	HORIZONTAL	TV	TELEVISION
HP	HORSEPOWER	TVS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
HTR	HEATER	TYP	TYPICAL
HV	HIGH VOLTAGE	U	UNDERFLOOR DUCT
HVAC	HEATING, VENTILATING, AND AIR CONDITIONING	UG	UNDERGROUND
HZ	HERTZ	UH	UNIT HEATER
		UL	UNDERWRITERS LABORATORIES
I	INTERNATIONAL BUILDING CODE	UNO	UNLESS NOTED OTHERWISE
IB	ISOLATED GROUND	UPS	UNINTERRUPTIBLE POWER SUPPLY
IG	ISOLATED GROUND	UTP	UNSHIELDED TWISTED-PAIR
IMC	INTERMEDIATE METALLIC CONDUIT	V	VOLT
INCAND	INCANDESCENT	VA	VOLT-AMPERE
J	JUNCTION BOX	VAV	VARIABLE AIR VOLUME
JCT	JUNCTION	VD	VOLTAGE DROP
K	THOUSAND CIRCULAR MILS	VENT	VENTILATION
KO	KNOCK OUT	VERT	VERTICAL
KV	KILOVOLT	VFD	VARIABLE FREQUENCY DRIVE
KVA	KILOVOLT AMPERES	VSD	VARIABLE SPEED DRIVE
KW	KILOWATT	W	WATT
KWH	KILOWATT HOURS	WP	WEATHER-PROOF (NEMA 3R)
		X	EXPLOSION PROOF
		XP	

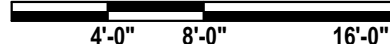
ELECTRICAL GENERAL NOTES			
1.	DO NOT SCALE DRAWINGS. VERIFY DIMENSIONS IN FIELD PRIOR TO COMMENCEMENT OF WORK.	12.	CONTRACTOR SHALL COORDINATE INSTALLATION OF ALL LIGHT FIXTURES TO ENSURE THAT THE LIGHT FIXTURES DO NOT INTERFERE WITH ANY STRUCTURAL, MECHANICAL, OR PLUMBING COMPONENTS AND EQUIPMENT. COORDINATE RELOCATION OF ANY LIGHT FIXTURES DUE TO INTERFERENCES WITH STRUCTURAL, MECHANICAL, OR PLUMBING COMPONENTS AND EQUIPMENT.
2.	ALL RECEPTABLES TO BE MOUNTED AT +18" UNLESS OTHERWISE NOTED. RECEPTABLE HEIGHTS SHALL COMPLY WITH ANSI 117.1 REQUIREMENTS	13.	FIXTURES RECESSED IN "T-BAR" CEILING SHALL BE SUPPORTED INDEPENDENTLY OF CEILING SYSTEM. WITH TWO #12 HANGER WIRES UP TO STRUCTURE. SECURE HANGER WIRES TO OPPOSITE CORNERS OF FIXTURE. CLIP FIXTURE TO GRID ON TWO SIDES WITH FACTORY-FURNISHED CLIPS. FINAL CONNECTION TO FIXTURE SHALL BE MADE WITH A FLEXIBLE UL APPROVED ASSEMBLY.
3.	REFER TO ARCHITECTURAL DEMOLITION DRAWINGS FOR LOCATION AND EXTENT OF DEMOLITION REQUIRED. CONTRACTOR SHALL VISIT SITE PRIOR TO BID TO DETERMINE EXTENT OF WORK INVOLVED. PROVIDE LABOR AND MATERIALS AS REQUIRED TO MAINTAIN AND/OR RESTORE CONTINUITY OF SERVICE TO EXISTING CIRCUITS.	14.	CONDUITS PENETRATING THROUGH ROOF SHALL HAVE ROOF FLASHING WITH CAULK TYPE COURTER FLASHING SLEEVE. INSTALLATION SHALL BE WATER-TIGHT. CONDUITS SHALL NOT BE RUN HORIZONTALLY ON THE ROOF. PENETRATIONS SHALL BE AT EQUIPMENT LOCATIONS ONLY AND SHALL BE COORDINATED WITH MECHANICAL EQUIPMENT.
4.	CONTRACTOR SHALL PROVIDE ALL NECESSARY DEMOLITION TO REMOVE EXISTING UNUSED CONDUIT, WIRE, CABLE, JUNCTION BOXES, RECEPTABLES, SWITCHES, LIGHTS, ETC COMPLETE WITH ASSOCIATED CIRCUITING TO SOURCE.	15.	FINAL CONNECTIONS TO MOTORS, TRANSFORMERS AND OTHER VIBRATING EQUIPMENT SHALL BE WITH FLEXIBLE METAL CONDUIT (INDOORS) OR LIQUIDTIGHT FLEXIBLE METAL CONDUIT (OUTDOORS) AND APPROVED FITTINGS. DO NOT SECURE CONDUITS, DISCONNECTS OR DEVICES TO DUCTWORK OR MECHANICAL EQUIPMENT.
5.	SYSTEM OUTAGES SHALL BE PERMITTED ONLY AT TIMES APPROVED BY OWNER. IN WRITING. WORK WHICH COULD RESULT IN AN ACCIDENTAL OUTAGE (BEYOND BRANCH CIRCUITS) SHALL BE PERFORMED WITH THE OWNER'S MAINTENANCE PERSONNEL ADVISED OF SUCH WORK.	16.	WIRE TERMINATION PROVISIONS FOR PANELBOARDS, CIRCUIT BREAKERS, SAFETY SWITCHES, AND ALL OTHER ELECTRICAL APPARATUS SHALL BE LISTED AS SUITABLE FOR 75°C.
6.	PRIOR TO COMMENCEMENT OF ROUGH-IN WORK, COORDINATE WITH ARCHITECT, DRAWING NOTES, ELEVATIONS, SECTIONS, SPECIFICATIONS, FURNITURE, FIXTURES, AND EQUIPMENT FOR ALL RECEPTABLE AND COMMUNICATION DEVICE MOUNTING HEIGHT AND MOUNTING LOCATION.	17.	CONTRACTOR SHALL PROVIDE A VOLTAGE BARRIER IN BOXES CONTAINING MULTIPLE SWITCHES WITH A VOLTAGE POTENTIAL OF 300V OR GREATER.
7.	ALL 120V, SINGLE PHASE, 15 AND 20 AMP RECEPTABLE OUTLETS THAT ARE USED AS TEMPORARY POWER DURING CONSTRUCTION SHALL HAVE GFCI PROTECTION.	18.	COORDINATE ELECTRICAL DEVICES AND EQUIPMENT WITH THE INTERIOR AND ARCHITECTURAL DRAWINGS. IF CONFLICTS OCCUR, BRING THEM TO THE ARCHITECTS ATTENTION PROMPTLY.
8.	ALL PENETRATIONS, SLEEVES, OPENINGS, ETC. THROUGH SMOKE OR FIRE RATED WALLS, CEILING, OR FLOORS SHALL BE PROPERLY CAULKED WITH AN APPROVED FIRE CAULKING MATERIAL, APPROVED BY ENGINEER, UNLESS NOTED OTHERWISE.	19.	CONTRACTOR SHALL COORDINATE WITH OTHER TRADES TO INSURE THAT PIPING, DUCTS, ETC. INSTALLED WITHIN ELECTRICAL ROOMS OR SPACES SHALL BE INSTALLED PER NEC 110-26. ALL PIPING, DUCTS, ETC. SHALL BE INDICATED ON THE SHOP DRAWINGS.
9.	ALL PENETRATIONS THROUGH SOUND, SECURITY OR FIRE WALLS SHALL BE SLEEVED FOR MECHANICAL PROTECTION. ALL PENETRATIONS AND SLEEVES SHALL BE SEALED WITH CAULKING AND INTUMESCENT MATERIAL (WHERE APPROPRIATE) TO MAINTAIN RESPECTIVE RATINGS OF WALL.	20.	EACH RECEPTABLE INSTALLED OUTDOORS, WITHIN 72" OF SINKS, ELECTRIC WATER COOLERS, IN DAMP OR WET AREAS, ON ROOF, BELOW GRADE ELEVATOR PIT, JANITOR CLOSETS AND TOILET ROOMS, SHALL HAVE INDIVIDUAL GROUND FAULT (GFCI) PROTECTION.
10.	PROVIDE EQUIPMENT BONDING JUMPER GROUND CONNECTION IN ALL BOXES, ENCLOSURES, ETC. FROM THE EQUIPMENT GROUNDING CONDUCTOR.	21.	REFER TO MECHANICAL CONTROL DIAGRAMS FOR ADDITIONAL WIRING REQUIREMENTS. PROVIDE ALL RACEWAYS, WIRING, CONTROL SWITCHES, ETC AS REQUIRED.
11.	ALL EMPTY RACEWAY SYSTEMS SHALL HAVE A #12 PULLWIRE OR EQUAL AND SHALL BE IDENTIFIED AT ALL JUNCTIONS, PULL AND TERMINATION POINTS, USING PERMANENT METALLIC TAGS. TAG SHALL INDICATE INTENDED USE OF CONDUIT, ORIGINATION AND TERMINATION POINTS OF EACH INDIVIDUAL CONDUIT.	22.	FINAL CONNECTIONS TO EQUIPMENT SHALL BE PER MANUFACTURERS APPROVED WIRING DIAGRAMS, DETAILS AND INSTRUCTIONS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE MATERIALS AND EQUIPMENT COMPATIBLE WITH EQUIPMENT SUPPLIED.

ELECTRICAL SYMBOL LEGEND										
(THIS IS A MASTER LEGEND, NOT ALL SYMBOLS MAY APPEAR ON DRAWINGS.)										
GENERAL			WIRING DEVICES			DIAGRAMS				
SYMBOL	DESCRIPTION		SYMBOL	DESCRIPTION		SYMBOL	DESCRIPTION			
	KEY NOTE		IG 5	RECEPTACLE RATED 20A, 125V, MOUNTED AT +18" UNLESS NOTED OTHERWISE. RECEPTACLE HEIGHTS SHALL COMPLY WITH ANSI 117.1 REQUIREMENTS			TRANSFORMER			
	FEEDER NOTE		5	"S" - INDICATES CIRCUIT NUMBER			CIRCUIT BREAKER			
	KITCHEN EQUIPMENT TAG		WP 5	"F" - INDICATES FOOD CART RECEPTACLE			SHUNT TRIP CIRCUIT BREAKER			
	REVISION NUMBER		5	"H" - INDICATES RECEPTACLE INSTALLED HORIZONTAL			DRAW-OUT CIRCUIT BREAKER - MEDIUM VOLTAGE			
	ELECTRICAL EQUIPMENT TAG		5	"IG" - INDICATES ISOLATED GROUND TYPE			DRAW-OUT CIRCUIT BREAKER - LOW VOLTAGE			
	MECHANICAL EQUIPMENT TYPE		5	"WP" - INDICATES WEATHERPROOF GFCI RECEPTACLE			SWITCH FUSE			
	MECHANICAL EQUIPMENT NUMBER		5	"SP" - INDICATES SURGE PROTECTION			GENERATOR			
	SECTION DRAWING NUMBER		5	"T" - INDICATES TAMPER RESISTANT			POTENTIAL TRANSFORMER			
	REFERENCING SHEET		5	"TC" - INDICATES TECHNOLOGY RECEPTACLE, REFER TO TECHNOLOGY DRAWINGS FOR ADDITIONAL INFORMATION			CURRENT TRANSFORMER			
	CALLOUT DRAWING NUMBER		5	"C" - INDICATES COUNTER HEIGHT			GROUNDING ELECTRODE			
	REFERENCING SHEET		5	"T" - INDICATES TAMPER RESISTANT			METER			
EXISTING DEVICE LEGEND			DIAGRAMS							
SYMBOL	DESCRIPTION		DESCRIPTION							
	NEW WORK			RECEPTACLE ON EMERGENCY POWER				AUTOMATIC TRANSFER SWITCH		
	EXISTING WORK TO REMAIN			HALF SWITCHED RECEPTACLE / CONTROLLED RECEPTACLE				AUTOMATIC TRANSFER SWITCH WITH BYPASS MAINTENANCE		
	EXISTING WORK TO BE REMOVED (DEMO)			SINGLE RECEPTACLE				CAPACITOR		
	EXISTING WORK TO BE RELOCATED			DUPLEX RECEPTACLE				SURGE PROTECTION DEVICE		
	NEW LOCATION OF EXISTING WORK			DOUBLE DUPLEX RECEPTACLE				KIRK KEY INTERLOCK		
				DOUBLE DUPLEX RECEPTACLE				AMMETER		
				FLUSH FLOOR/CEILING DUPLEX RECEPTACLE				VOLTMETER		
				FLUSH FLOOR/CEILING DOUBLE DUPLEX RECEPTACLE				WATT METER		
				SPECIAL PURPOSE RECEPTACLE - WALL / FLOOR / CEILING "XX" INDICATES TAG NUMBER, REFER TO SPECIAL PURPOSE RECEPTACLE SCHEDULE				WATT HOUR METER		
				HOSPITAL GRADE RECEPTACLE				SHUNT TRIP DEVICE		
				HOSPITAL GRADE DOUBLE DUPLEX RECEPTACLE				PANELBOARD		
				MULTI-OUTLET PLUG/STRIP				PANEL		
				MULTI-OUTLET ASSEMBLY, DEVICES AS INDICATED				PANEL		
				WALL JUNCTION BOX				PANEL		
				FLOOR/CEILING JUNCTION BOX				PANEL		
				JUNCTION BOX AND SWITCH WITH CONNECTION TO FIRE/SMOKE DAMPER, COORDINATE REQUIREMENTS WITH FIRE ALARM SYSTEM AND MECHANICAL CONTROL DIAGRAMS				PANEL		
				JUNCTION BOX AND SWITCH WITH CONNECTION TO VARIABLE AIR VOLUME BOX, COORDINATE REQUIREMENTS WITH MECHANICAL CONTROL DIAGRAMS				PANEL		
				DOOR HOLDER				PANEL		
				CLOCK RECEPTACLE AT +90° UNLESS NOTED OTHERWISE				PANEL		
				SPECIALTY BOX - WALL / FLOOR / CEILING				PANEL		
				FLOOR MOUNTED BOX FOR POWER CONNECTION TO PRE-WIRED FURNITURE PARTITIONS				PANEL		
				WALL MOUNTED BOX FOR POWER CONNECTION TO PRE-WIRED FURNITURE PARTITIONS				PANEL		
				FLOOR MOUNTED BOX WITH MULTIPLE DEVICES				PANEL		
				"FBI" INDICATES TYPE AS DEFINED IN NOTES/SCHEDULES.				PANEL		
				PULL BOX				PANEL		
				POWER POLE				PANEL		
				CORD DROP WITH DUPLEX RECEPTACLE				PANEL		
				CORD DROP WITH DOUBLE DUPLEX RECEPTACLE				PANEL		
				CORD DROP WITH SPECIAL PURPOSE RECEPTACLE, "XX" INDICATES TAG NUMBER, REFER TO SPECIAL PURPOSE RECEPTACLE SCHEDULE				PANEL		
LIGHTING			BRANCH CIRCUITS AND FEEDERS							
SYMBOL	DESCRIPTION		DESCRIPTION							
A1	LIGHTING FIXTURE (SEE LIGHTING FIXTURE SCHEDULE)			BRANCH CIRCUIT HOME RUN TICKS INDICATE QUANTITY OF CONDUCTORS. GROUND CONDUCTORS ARE NOT INDICATED. NO TICKS INDICATES 20/2 & 18/2 IN 3/4" MINIMUM. R22A-1,3,5 INDICATES PANEL AND CIRCUIT DESIGNATION FROM WHICH HOMERUN SHALL ORIGINATE. EACH CIRCUIT SHALL BE 20A-1P (20AMP SINGLE POLE) UNLESS NOTED OTHERWISE.				CONDUIT BELOW FLOOR OR BELOW GRADE		
2, a	"A1" - INDICATES LIGHTING FIXTURE TYPE			CONDUIT STUB OUT				CONDUIT AND/OR WIRE TURNED UP		
	"2" - INDICATES CIRCUIT NUMBER			CONDUIT AND/OR WIRE TURNED DOWN				FLEXIBLE CONNECTION TO EQUIPMENT, RACEWAY AND CONDUCTOR RATING TO MATCH ASSOCIATED BRANCH CIRCUIT OR FEEDER		
	"a" - INDICATES SWITCH CONTROL			BRANCH CIRCUIT FOR EMERGENCY BATTERY DC CIRCUIT, MINIMUM 2810 IN 3/4"				FEEDER HOMERUN, REFER TO LEGEND OF FEEDER SIZES FOR CONDUCTOR AND RACEWAY REQUIREMENTS DESIGNATED INSIDE TAG. H42B-1 INDICATES PANEL AND CIRCUIT NUMBER DESIGNATION FROM WHICH HOME RUN SHALL ORIGINATE, 100A-3P INDICATES 100 AMPERE, 3 POLE CIRCUIT BREAKER		
	FIXTURE SHADING INDICATES FIXTURE ON EMERGENCY CIRCUIT, LIFE SAFETY OR INTEGRAL BATTERY BACK-UP			H42B-1 100A-3P				MOTOR AND CONTROLS		
	FIXTURE HALF SHADING INDICATES FIXTURE ON CRITICAL BRANCH CIRCUITING			MOTOR, NUMERICAL INDICATES HORSEPOWER				HEAT TRACE		
	LINEAR PENDANT FIXTURE			MANUAL MOTOR STARTING SWITCH WITH THERMAL OVERLOAD PROTECTION				MAGNETIC MOTOR STARTER, REFER TO MAGNETIC MOTOR STARTER A VFD SCHEDULE FOR TYPE, SIZE AND ENCLOSURE		
	LINEAR STRIP FIXTURE			COMBINATION FUSED DISCONNECT MAGNETIC MOTOR STARTER, REFER TO MAGNETIC MOTOR STARTER AND VFD SCHEDULE FOR TYPE, SIZE AND ENCLOSURE				MOTOR CONTROL CENTER		
	RECESSED LINEAR SLOT LIGHT			EQUIPMENT CONTROL PANEL				VARIABLE SPEED DRIVE		
	LINEAR LED FIXTURE			MOTOR, NUMERICAL INDICATES HORSEPOWER				DISCONNECT SWITCH RATED 30AMP, 3-POLE, IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	DOWNLIGHT FIXTURE			FUSED DISCONNECT SWITCH, 3-POLE, IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				"3R" - INDICATES NEMA TYPE 3R ENCLOSURE		
	PENDANT FIXTURE			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				"2P" - INDICATES 2 POLE SINGLE PHASE DISCONNECT		
	TRACK LIGHT WITH FIXTURE HEADS			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				"60AS" - INDICATES 60A SWITCH		
	WALL WASH / ACCENT LIGHT			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				"60AF" - INDICATES 60AMP FUSES		
	SPECIALTY FIXTURE - PROFILE SPOT LIGHT			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	SPECIALTY FIXTURE - WASH LIGHT			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	WALL MOUNTED FIXTURE			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	STEP LIGHT			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	POLE MOUNTED FIXTURE			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	BOLLARD FIXTURE			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	EXIT SIGN WITH DIRECTIONAL ARROWS AND EXIT FACE (SHADED) AS INDICATED			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	EXIT SIGN WITH DIRECTIONAL ARROWS AND EXIT FACE (SHADED) AS INDICATED			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	EMERGENCY BATTERY LIGHTING UNIT WITH TWIN HEADS			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
	EMERGENCY BATTERY LIGHTING UNIT WITH TWIN HEADS AND EXIT SIGN			ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED				ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED		
POWER DISTRIBUTION			SWITCHING DEVICES							
SYMBOL	DESCRIPTION		DESCRIPTION							
	DARK SHADING ON EQUIPMENT INDICATES 208/120V, LIGHT SHADING INDICATES 480/277V			SINGLE POLE SWITCH AT +44° UNLESS NOTED OTHERWISE, MOUNTING HEIGHTS SHALL COMPLY WITH ANSI 117.1 REQUIREMENTS (AT +44° UNLESS NOTED OTHERWISE)				"2P" - INDICATES 2 POLE SINGLE THROW SWITCH		
	SURFACE MOUNTED PANELBOARD			"3" - INDICATES 3-WAY SWITCH				"4" - INDICATES 4-WAY SWITCH		
	FLUSH MOUNTED PANELBOARD			"4P" - INDICATES 4-WAY SWITCH				"L" - INDICATES LOW VOLTAGE SWITCH		
	DRY TYPE TRANSFORMER			"D" - INDICATES DIMMER SWITCH - SOLID STATE TYPE				"F" - INDICATES FUSE		
	TWISTED SHIELDED-PAIR			"F" - INDICATES FUSE				"M" - INDICATES MOMENTARY CONTACT SWITCH		
	SWITCHBOARD, MOTOR CONTROL CENTER OR DISTRIBUTION BOARD			"M" - INDICATES MOMENTARY CONTACT SWITCH				"T" - INDICATES TIME CLOCK		
	LIGHTING CONTROL PANEL			"T" - INDICATES TIME CLOCK				"TM" - INDICATES SWITCH WITH DIGITAL TIMER		
	CONTROL PANEL			"TM" - INDICATES SWITCH WITH DIGITAL TIMER				"TD" - INDICATES SWITCH WITH TIME DELAY		
	LADDER CABLE TRAY			"TD" - INDICATES SWITCH WITH TIME DELAY				"W" - WIRELESS SWITCH		
	CHANNEL CABLE TRAY			"W" - WIRELESS SWITCH				"WP" - INDICATES WEATHERPROOF		
	BUSWAY, HORIZONTAL, REFER TO RISER FOR RATING			"WP" - INDICATES WEATHERPROOF				CEILING/WALL DAYLIGHT SENSOR		
	BUSWAY, VERTICAL, REFER TO RISER FOR RATING			CEILING/WALL DAYLIGHT SENSOR				DIMMING MODULE		
	BUSWAY, HORIZONTAL, WITH FUSED PLUG-IN DISCONNECT			DIMMING MODULE				CEILING/WALL OCCUPANCY SENSOR (XX REFERS TO TYPE DESIGNATION, SEE OCCUPANCY SENSOR SCHEDULE - L / WALL / CEILING		
	GROUND BAR			CEILING/WALL OCCUPANCY SENSOR (XX REFERS TO TYPE DESIGNATION, SEE OCCUPANCY SENSOR SCHEDULE - L / WALL / CEILING				PHOTO CELL - WALL / CEILING		
	CUSTOMER METER			PHOTO CELL - WALL / CEILING				RELAY - WALL / CEILING		
	UTILITY METER AND SOCKET			RELAY - WALL / CEILING				EMERGENCY SUPERVISORY BYPASS RELAY		
	CURRENT TRANSFORMER CABINET			EMERGENCY SUPERVISORY BYPASS RELAY				ROOM CONTROLLER		
				ROOM CONTROLLER				SWITCHING MODULE		
				SWITCHING MODULE				PUSHBUTTON TYPE CONTROL STATION, "EPO" INDICATES EMERGENCY POWER OFF		
				PUSHBUTTON TYPE CONTROL STATION, "EPO" INDICATES EMERGENCY POWER OFF				TOUCH PANEL		
				TOUCH PANEL				PRESET STATION		
				PRESET STATION						

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1 ELECTRICAL POWER DEMO PLAN - LEVEL 4
ED104 3/16" = 1'-0"



SHEET NOTES

- A. ELECTRICAL DEMO PLANS ARE NOT INTENDED TO SHOW ALL ITEMS TO BE DEMOLISHED OR RETAINED. DISCONNECT AND MAKE SAFE DEVICES AND EQUIPMENT LOCATED ON WALLS AND/OR CEILINGS TO BE REMOVED. NOTIFY THE OWNER IMMEDIATELY OF ANY UNANTICIPATED HIDDEN CONDITIONS ENCOUNTERED DURING DEMOLITION WORK.
- B. PERFORM ELECTRICAL DEMO WORK AS SHOWN ON THE DRAWINGS AND AS SPECIFIED IN COOPERATION WITH THE OTHER TRADES AND AS SCHEDULED AND APPROVED BY THE OWNER. DISCONNECT AND MAKE SAFE ALL ELECTRICAL EQUIPMENT IDENTIFIED FOR REMOVAL ON ELECTRICAL, HVAC, PLUMBING AND FIRE PROTECTION PLANS.
- C. POWER OUTAGES AS A RESULT OF DEMO WORK THAT AFFECT OTHER AREAS SHALL BE COORDINATED WITH USERS AND SHALL BE KEPT TO A MINIMUM. NIGHT, WEEKEND, AND/OR HOLIDAY TIME REQUIRED TO PERFORM DEMO WORK SHALL BE CARRIED AS PART OF THE CONTRACT COST.
- D. CIRCUIT TRACE AND LABEL ALL EXISTING BRANCH CIRCUITS AND FEEDERS WITHIN AREA OF DEMOLITION PRIOR TO DE-ENERGIZING.
- E. PROMPTLY REPAIR ANY DAMAGE CAUSED DURING THE EXECUTION OF DEMO WORK. DAMAGE INCLUDES BUT NOT LIMITED TO ITEMS INTENDED TO REMAIN OR TO BE SALVAGED.
- F. ALL DEMOLISHED EQUIPMENT SHALL BE OFFERED TO OWNER AS SALVAGE. IF OWNER DOES NOT TAKE POSSESSION OF ITEMS CONTRACTOR TO DISPOSE OF ITEMS IN A SAFE AND LEGAL MANNER AS REQUIRED BY LOCAL, STATE AND FEDERAL LAWS.

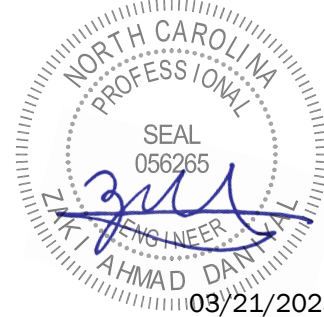
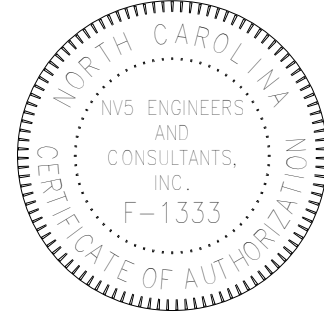
KEY NOTES (X)

1. EQUIPMENT TO BE DEMOLISHED. EC TO DEMOLISH EXISTING FUSED DISCONNECT AND CONDUIT BACK TO SOURCE PANEL AC.
2. EQUIPMENT TO BE DEMOLISHED DURING PHASE 1.
3. EQUIPMENT TO BE DEMOLISHED DURING PHASE 2.
4. EXISTING BAS PANEL. COORDINATE EXACT LOCATION WITH MECHANICAL DRAWINGS. NEW BAS PANEL TO BE INSTALLED NEXT TO EXISTING BAS PANEL. EXTEND EXISTING POWER WIRING AND COMMUNICATION WIRING FROM THE EXISTING BAS PANEL TO NEW BAS PANEL TO BE LOCATED ADJACENT TO EXISTING PANEL LOCATION.

N|V|5

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CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120
DESIGNED BY: ZAD
CHECKED BY: ZAD
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

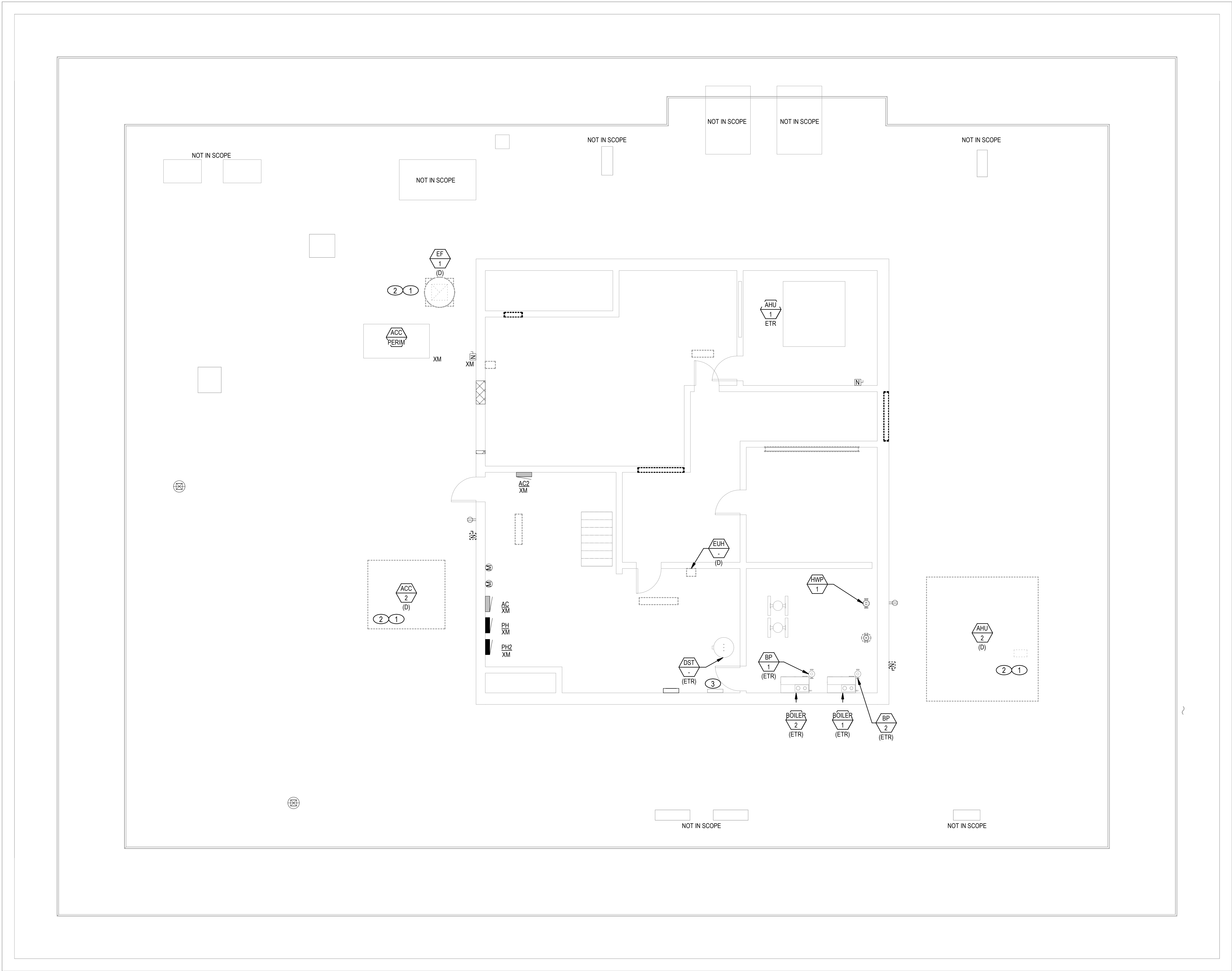
SHEET NAME

ELECTRICAL
POWER DEMO
PLAN - LEVEL 4 -
PHASE I

SHEET NUMBER

ED104

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ELECTRICAL POWER DEMO PLAN - LEVEL 4 - PHASE

1 II
ED105 3/16" = 1'-0"

SHEET NOTES

- ELECTRICAL DEMO PLANS ARE NOT INTENDED TO SHOW ALL ITEMS TO BE DEMOLISHED OR RETAINED. DISCONNECT AND MAKE SAFE DEVICES AND EQUIPMENT LOCATED ON WALLS AND/OR CEILINGS TO BE REMOVED. NOTIFY THE OWNER IMMEDIATELY OF ANY UNANTICIPATED HIDDEN CONDITIONS ENCOUNTERED DURING DEMOLITION WORK.
- PERFORM ELECTRICAL DEMO WORK AS SHOWN ON THE DRAWINGS AND AS SPECIFIED IN COOPERATION WITH THE OTHER TRADES AND AS SCHEDULED AND APPROVED BY THE OWNER. DISCONNECT AND MAKE SAFE ALL ELECTRICAL EQUIPMENT IDENTIFIED FOR REMOVAL ON ELECTRICAL, HVAC, PLUMBING AND FIRE PROTECTION PLANS.
- POWER OUTAGES AS A RESULT OF DEMO WORK THAT AFFECT OTHER AREAS SHALL BE COORDINATED WITH USERS AND SHALL BE KEPT TO A MINIMUM. NIGHT, WEEKEND, AND/OR HOLIDAY TIME REQUIRED TO PERFORM DEMO WORK SHALL BE CARRIED AS PART OF THE CONTRACT COST.
- CIRCUIT TRACE AND LABEL ALL EXISTING BRANCH CIRCUITS AND FEEDERS WITHIN AREA OF DEMOLITION PRIOR TO DE-ENERGIZING.
- PROMPTLY REPAIR ANY DAMAGE CAUSED DURING THE EXECUTION OF DEMO WORK. DAMAGE INCLUDES BUT NOT LIMITED TO ITEMS INTENDED TO REMAIN OR TO BE SALVAGED.
- ALL DEMOLISHED EQUIPMENT SHALL BE OFFERED TO OWNER AS SALVAGE. IF OWNER DOES NOT TAKE POSSESSION OF ITEMS CONTRACTOR TO DISPOSE OF ITEMS IN A SAFE AND LEGAL MANNER AS REQUIRED BY LOCAL, STATE AND FEDERAL LAWS.

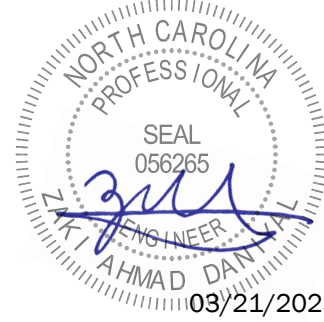
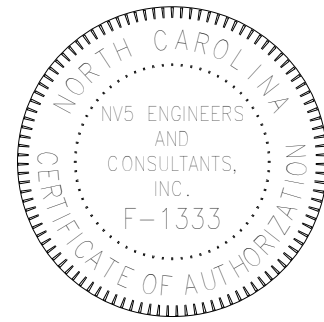
KEY NOTES

- EQUIPMENT TO BE DEMOLISHED. EC TO DEMOLISH EXISTING FUSED DISCONNECT AND CONDUIT BACK TO SOURCE PANEL AC.
- EQUIPMENT TO BE DEMOLISHED DURING PHASE 2.
- LOCATION OF NEW BAS PANEL. COORDINATE FINAL LOCATION WITH MECHANICAL DRAWINGS.

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CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120

DESIGNED BY: ZAD

CHECKED BY: ZAD

DATE: 03/21/2025

SCALE: 3/16" = 1'-0"

SHEET NAME

ELECTRICAL
POWER DEMO
PLAN - LEVEL 4 -
PHASE II

SHEET NUMBER

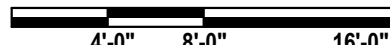
ED105

4'-0" 8'-0" 16'-0"



1. ALL ELECTRICAL EQUIPMENT IN ROOM IS EXISTING TO REMAIN

E101



Autodesk DWG2PDF - 14/08/2025 10:30:00 - GUC Admin Building HVAC Upgrade - MEP25-14
3/20/2025 4:08:17 PM

1 ELECTRICAL POWER PLAN - LEVEL 2
E102 3/16" = 1'-0"



SHEET NOTES

- A. REFER TO DRAWING E001 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
B. CIRCUIT NUMBERS ARE DIAGRAMMATIC. EXACT NUMBERS SHALL BE DETERMINED IN FIELD AND BE REFLECTED ON RECORD DRAWINGS BY THE ELECTRICAL CONTRACTOR. THE ASSOCIATED CIRCUIT NUMBERS THAT ARE APPLIED TO EACH DEVICE AND PIECE OF EQUIPMENT INFERS INTERCONNECTING BRANCH CIRCUITRY. INTERCONNECTING BRANCH WIRING SHALL BE SIZED EQUAL TO HOME RUN UNLESS NOTED OTHERWISE.
C. VOLTAGE DROP HAS BEEN CONSIDERED IN THE DESIGN OF ALL BRANCH CIRCUITRY AND FEEDERS ARE SIZED BASED ON THE ILLUSTRATE EQUIPMENT LAYOUT AND SHORTEST CONDUCTOR/RACEWAY ROUTING. THE EC IS RESPONSIBLE FOR ANY DEVIATIONS TAKEN THAT MAY INCREASE THE CONDUCTOR LENGTHS. BRANCH CIRCUITS LONGER THAN 75' FOR 120V FROM PANEL TO LAST OUTLET SHALL BE INCREASED A MINIMUM OF ONE SIZE ABOVE THAT SPECIFIED TO LIMIT VOLTAGE DROP TO LESS THAN 3%. FEEDERS SHALL FOLLOW SIMILAR GUIDELINES AND BE LIMITED TO 2% DROP.
D. POWER BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT.
E. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING POWER DEVICES TO REMAIN.

KEY NOTES

1. PANEL RP2B CIRCUIT NUMBER 6 AND 8 ARE UTILIZED TO PROVIDE CONTROL POWER FOR DEMOLISHED VAV BOXES. EC TO DEMOLISH CIRCUIT BACK TO SOURCE AND REFEED NEW VAV BOXES UTILIZING SAME BREAKERS.
2. COORDINATE CONTROLS TRANSFORMER AT EACH VAV BOX WITH CONTROLS CONTRACTOR.
3. PROVIDE AND INSTALL DUCT MOUNTED SMOKE DETECTOR COORDINATE FINAL LOCATION WITH MECHANICAL DRAWINGS.
4. ALL LEVEL 2 WORK IS TO BE PERFORMED IN PHASE 2. COORDINATE PHASING WITH MECHANICAL DRAWINGS.

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NORTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
F-1333
03/21/2025
THE PROFESSIONAL ENGINEER SEAL
SHALL BE PLACED ON ALL DRAWINGS. THE SEAL SHALL BE PLACED ON THE DRAWING IN THE RIGHT HAND CORNER. THE SEAL SHALL BE PLACED ON THE DRAWING IN THE RIGHT HAND CORNER. THE SEAL SHALL BE PLACED ON THE DRAWING IN THE RIGHT HAND CORNER.

CLIENT

CONSULTANT

PROJECT NAME
GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN

REVISION/ISSUANCE
DESCRIPTION DATE
CONSTRUCTION DOCUMENTS 03/21/25

PROJECT NO.: 24-0006120
DESIGNED BY: ZAD
CHECKED BY: ZAD
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

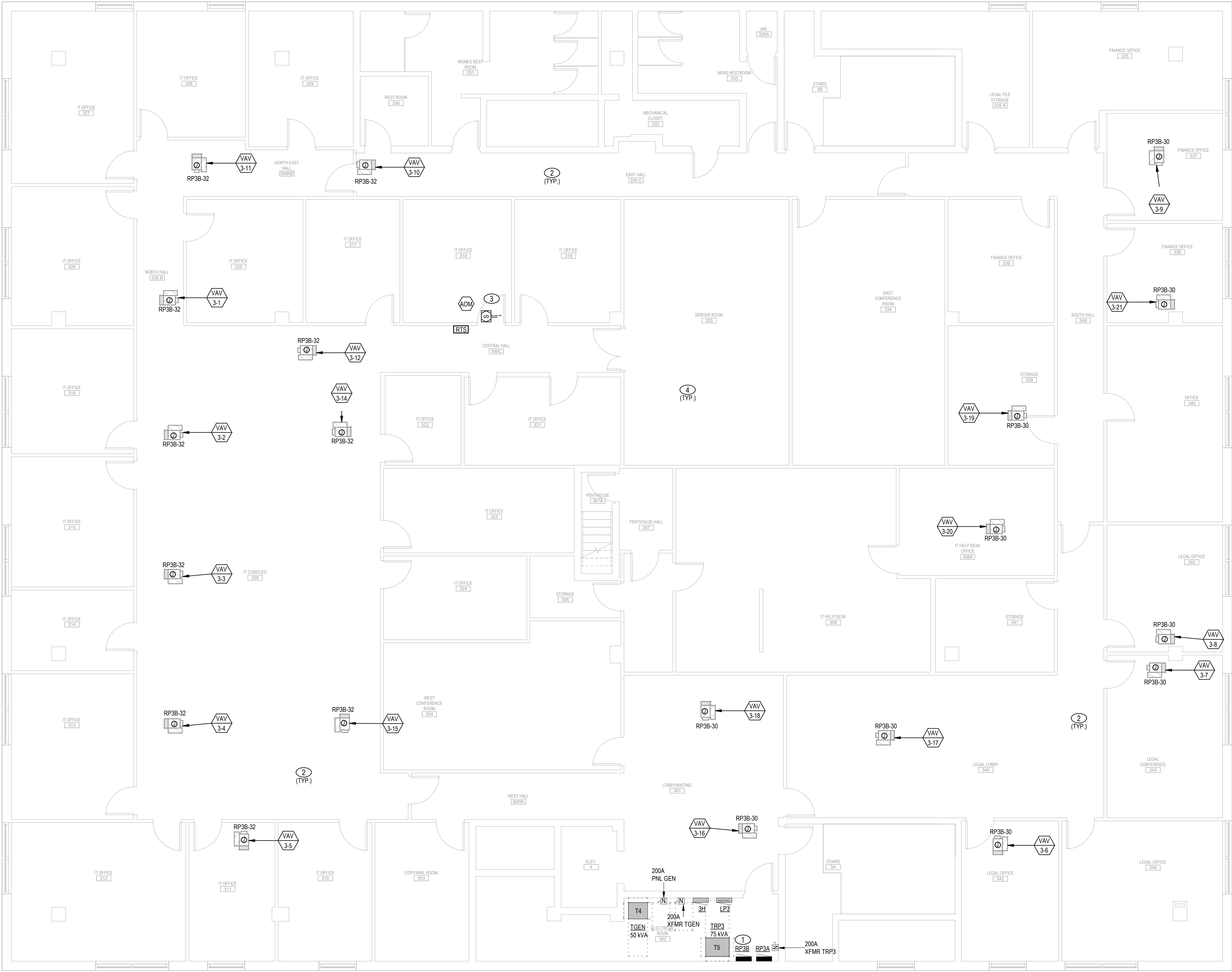
SHEET NAME
ELECTRICAL
POWER PLAN -
LEVEL 2

SHEET NUMBER
E102

4'-0" 8'-0" 16'-0"

Architect: Davis|Baker, AIA 0086120 - GUC Admin Building HVAC Upgrade, MEP/23-14
3/20/2025 4:02:25 PM

1 ELECTRICAL POWER PLAN - LEVEL 3
E103 3/16" = 1'-0"



SHEET NOTES

- A. REFER TO DRAWING E001 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
B. CIRCUIT NUMBERS ARE DIAGRAMMATIC. EXACT NUMBERS SHALL BE DETERMINED IN FIELD AND BE REFLECTED ON RECORD DRAWINGS BY THE ELECTRICAL CONTRACTOR. THE ASSOCIATED CIRCUIT NUMBERS THAT ARE APPLIED TO EACH DEVICE AND PIECE OF EQUIPMENT INFERS INTERCONNECTING BRANCH CIRCUITRY. INTERCONNECTING BRANCH WIRING SHALL BE SIZED EQUAL TO HOME RUN UNLESS NOTED OTHERWISE.
C. VOLTAGE DROP HAS BEEN CONSIDERED IN THE DESIGN OF ALL BRANCH CIRCUITRY AND FEEDERS ARE SIZED BASED ON THE ILLUSTRATE EQUIPMENT LAYOUT AND SHORTEST CONDUCTOR/RACEWAY ROUTING. THE EC IS RESPONSIBLE FOR ANY DEVIATIONS TAKEN THAT MAY INCREASE THE CONDUCTOR LENGTHS. BRANCH CIRCUITS LONGER THAN 75' FOR 120V FROM PANEL TO LAST OUTLET SHALL BE INCREASED A MINIMUM OF ONE SIZE ABOVE THAT SPECIFIED TO LIMIT VOLTAGE DROP TO LESS THAN 3%. FEEDERS SHALL FOLLOW SIMILAR GUIDELINES AND BE LIMITED TO 2% DROP.
D. POWER BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT.
E. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING POWER DEVICES TO REMAIN.

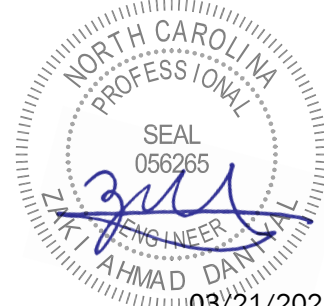
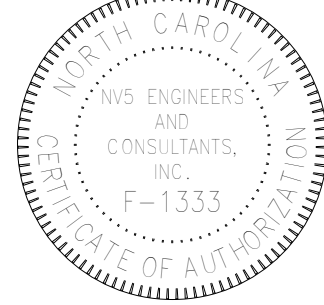
KEY NOTES

1. PANEL RP3B CIRCUIT NUMBER 30 AND 32 ARE UTILIZED TO PROVIDE CONTROL POWER FOR DEMOLISHED VAV BOXES. EC TO DEMOLISH CIRCUIT BACK TO SOURCE AND REFEED NEW VAV BOXES UTILIZING SAME BREAKERS.
2. COORDINATE CONTROLS TRANSFORMER AT EACH VAV BOX WITH CONTROLS CONTRACTOR.
3. PROVIDE AND INSTALL DUCT MOUNTED SMOKE DETECTOR COORDINATE FINAL LOCATION WITH MECHANICAL DRAWINGS.
4. ALL LEVEL 3 WORK IS TO BE PERFORMED IN PHASE 1, COORDINATE PHASING WITH MECHANICAL DRAWINGS.

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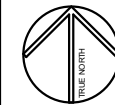
CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE

#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120

DESIGNED BY: ZAD

CHECKED BY: ZAD

DATE: 03/21/2025

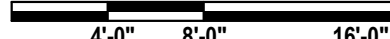
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SHEET NAME

ELECTRICAL
POWER PLAN -
LEVEL 3

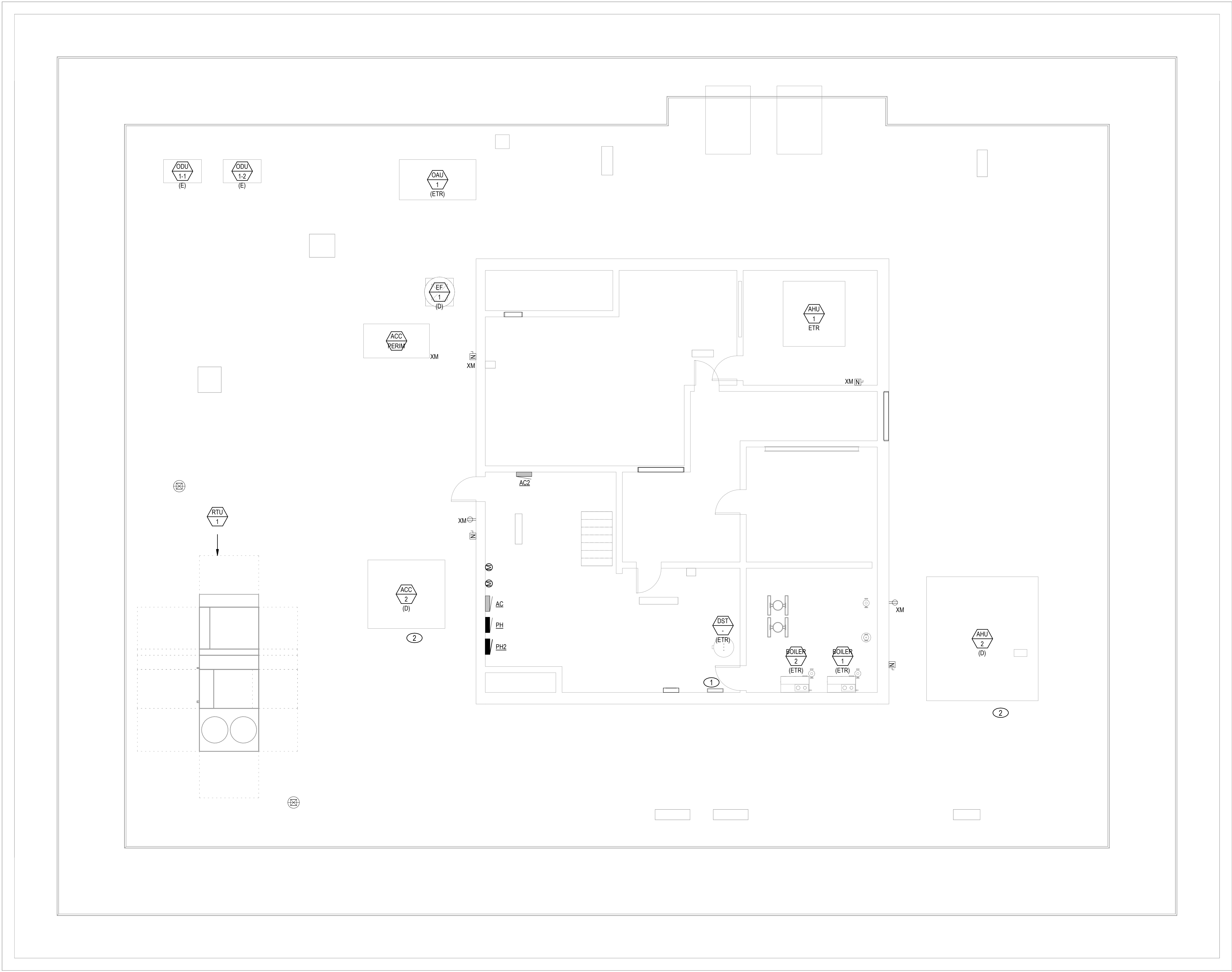
SHEET NUMBER

E103



Autodesk DWGPlotter 12.0 - 14/08/2025 10:30:00 - GUC Admin Building HVAC Upgrade - MEP/25-14
3/20/2025 10:30:00 PM

1 ELECTRICAL POWER PLAN - LEVEL 4
E104 3/16" = 1'-0"



SHEET NOTES

- A. REFER TO DRAWING E001 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
- B. CIRCUIT NUMBERS ARE DIAGRAMMATIC. EXACT NUMBERS SHALL BE DETERMINED IN FIELD AND BE REFLECTED ON RECORD DRAWINGS BY THE ELECTRICAL CONTRACTOR. THE ASSOCIATED CIRCUIT NUMBERS THAT ARE APPLIED TO EACH DEVICE AND PIECE OF EQUIPMENT INFERS INTERCONNECTING BRANCH CIRCUITRY. INTERCONNECTING BRANCH WIRING SHALL BE SIZED EQUAL TO HOME RUN UNLESS NOTED OTHERWISE.
- C. VOLTAGE DROP HAS BEEN CONSIDERED IN THE DESIGN OF ALL BRANCH CIRCUITRY AND FEEDERS ARE SIZED BASED ON THE ILLUSTRATE EQUIPMENT LAYOUT AND SHORTEST CONDUCTOR/RACEWAY ROUTING. THE EC IS RESPONSIBLE FOR ANY DEVIATIONS TAKEN THAT MAY INCREASE THE CONDUCTOR LENGTHS. BRANCH CIRCUITS LONGER THAN 75' FOR 120V FROM PANEL TO LAST OUTLET SHALL BE INCREASED A MINIMUM OF ONE SIZE ABOVE THAT SPECIFIED TO LIMIT VOLTAGE DROP TO LESS THAN 3%. FEEDERS SHALL FOLLOW SIMILAR GUIDELINES AND BE LIMITED TO 3% DROP. POWER BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT.
- D. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING POWER DEVICES TO REMAIN.

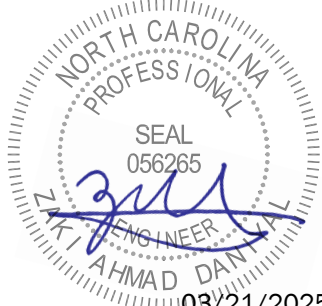
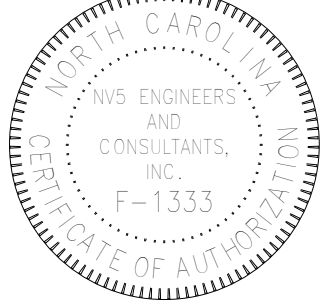
KEY NOTES (X)

1. NEW BUILDING BAS PANEL. CONTROL WIRING CONNECTION FROM BUILDING ATS IN GENERATOR YARD TO BAS PANEL IS EXISTING TO REMAIN. CURRENT PROGRAM SCHEME WHEREBY ALL HVAC LOAD IS LIMITED TO 75% CAPACITY WHEN THE ATS SWITCHES OVER TO STANDBY POWER IS REMAINING AND SCHEMATIC TO BE PROGRAMED INTO NEW BAS CONTROLLER. REFER TO MECHANICAL DRAWINGS FOR MORE DETAIL.
2. EQUIPMENT TO BE DEMOLISHED IN PHASE 2.

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CLIENT

CONSULTANT

PROJECT NAME

**GUC ADMIN
BUILDING HVAC
UPGRADE**

KEY PLAN



REVISION/ISSUANCE		
#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120
DESIGNED BY: ZAD
CHECKED BY: ZAD
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

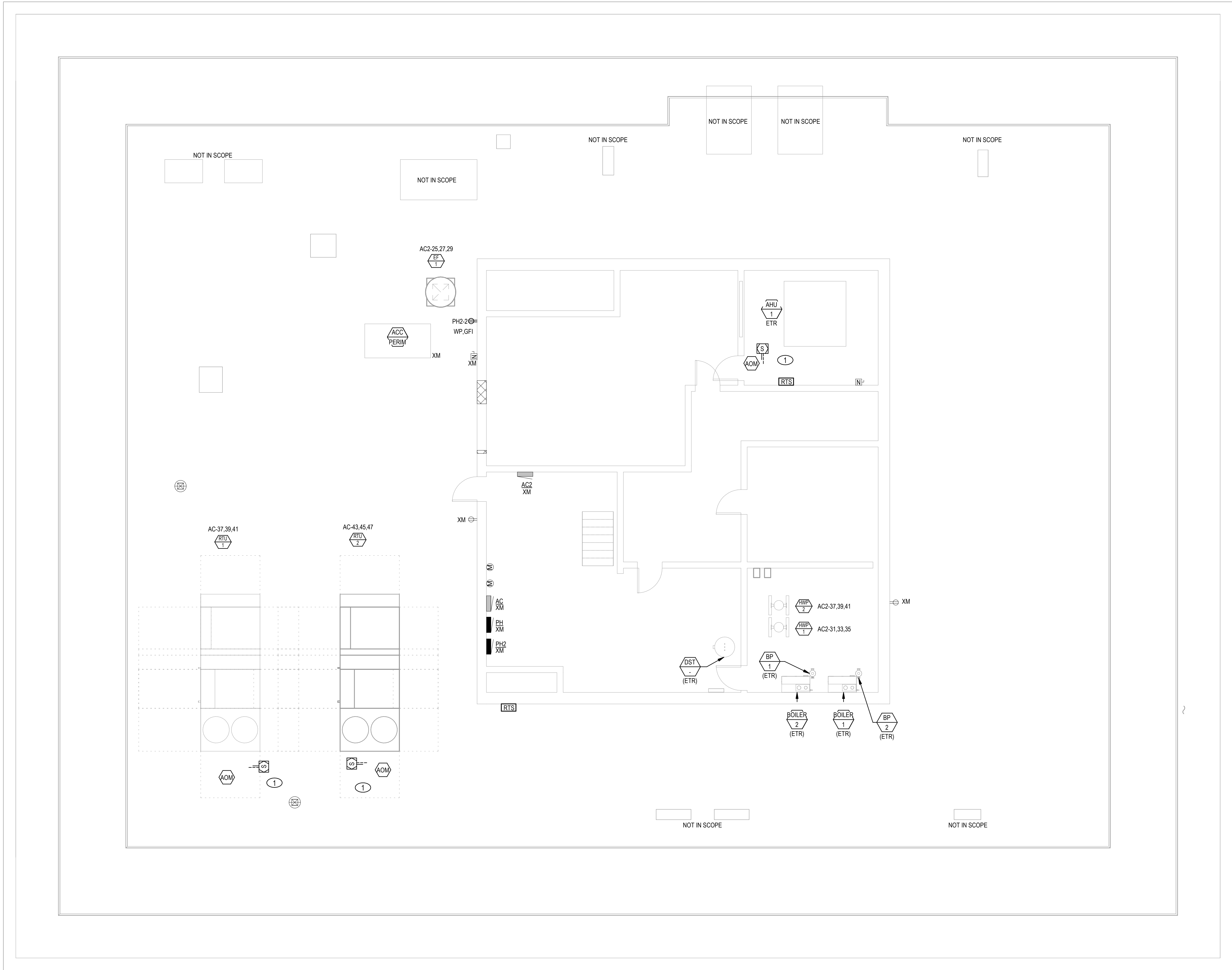
SHEET NAME
**ELECTRICAL
POWER PLAN -
LEVEL 4 PHASE I**

SHEET NUMBER

E104

4'-0" 8'-0" 16'-0"

Autodesk DWGPlotter 2024-04-08 10:20 - GUC Admin Building HVAC Upgrade MEP23.rvt
3/20/2025 4:08:32 PM



1 ELECTRICAL POWER PLAN - LEVEL 4 - PHASE II
E105 3/16" = 1'-0"

SHEET NOTES

- A. REFER TO DRAWING E001 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
- B. CIRCUIT NUMBERS ARE DIAGRAMMATIC. EXACT NUMBERS SHALL BE DETERMINED IN FIELD AND BE REFLECTED ON RECORD DRAWINGS BY THE ELECTRICAL CONTRACTOR. THE ASSOCIATED CIRCUIT NUMBERS THAT ARE APPLIED TO EACH DEVICE AND PIECE OF EQUIPMENT INFERS INTERCONNECTING BRANCH CIRCUITRY. INTERCONNECTING BRANCH WIRING SHALL BE SIZED EQUAL TO HOME RUN UNLESS NOTED OTHERWISE.
- C. VOLTAGE DROP HAS BEEN CONSIDERED IN THE DESIGN OF ALL BRANCH CIRCUITRY AND FEEDERS ARE SIZED BASED ON THE ILLUSTRATE EQUIPMENT LAYOUT AND SHORTEST CONDUCTOR/RACEWAY ROUTING. THE EC IS RESPONSIBLE FOR ANY DEVIATIONS TAKEN THAT MAY INCREASE THE CONDUCTOR LENGTHS. BRANCH CIRCUITS LONGER THAN 75' FOR 120V FROM PANEL TO LAST OUTLET SHALL BE INCREASED A MINIMUM OF ONE SIZE ABOVE THAT SPECIFIED TO LIMIT VOLTAGE DROP TO LESS THAN 3%. FEEDERS SHALL FOLLOW SIMILAR GUIDELINES AND BE LIMITED TO 2% DROP.
- D. POWER BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT.
- E. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING POWER DEVICES TO REMAIN.

KEY NOTES

1. PROVIDE AND INSTALL DUCT MOUNTED SMOKE DETECTOR. COORDINATE FINAL LOCATION WITH MECHANICAL DRAWINGS.

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NORTH CAROLINA
REGISTERED ELECTRICAL ENGINEER
AND CONSULTANT
F-1333
NORTH CAROLINA
PROFESSIONAL SEAL
03/21/2025
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CLIENT

CONSULTANT

PROJECT NAME
GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN

REVISION/ISSUANCE
DESCRIPTION DATE
CONSTRUCTION DOCUMENTS 03/21/25

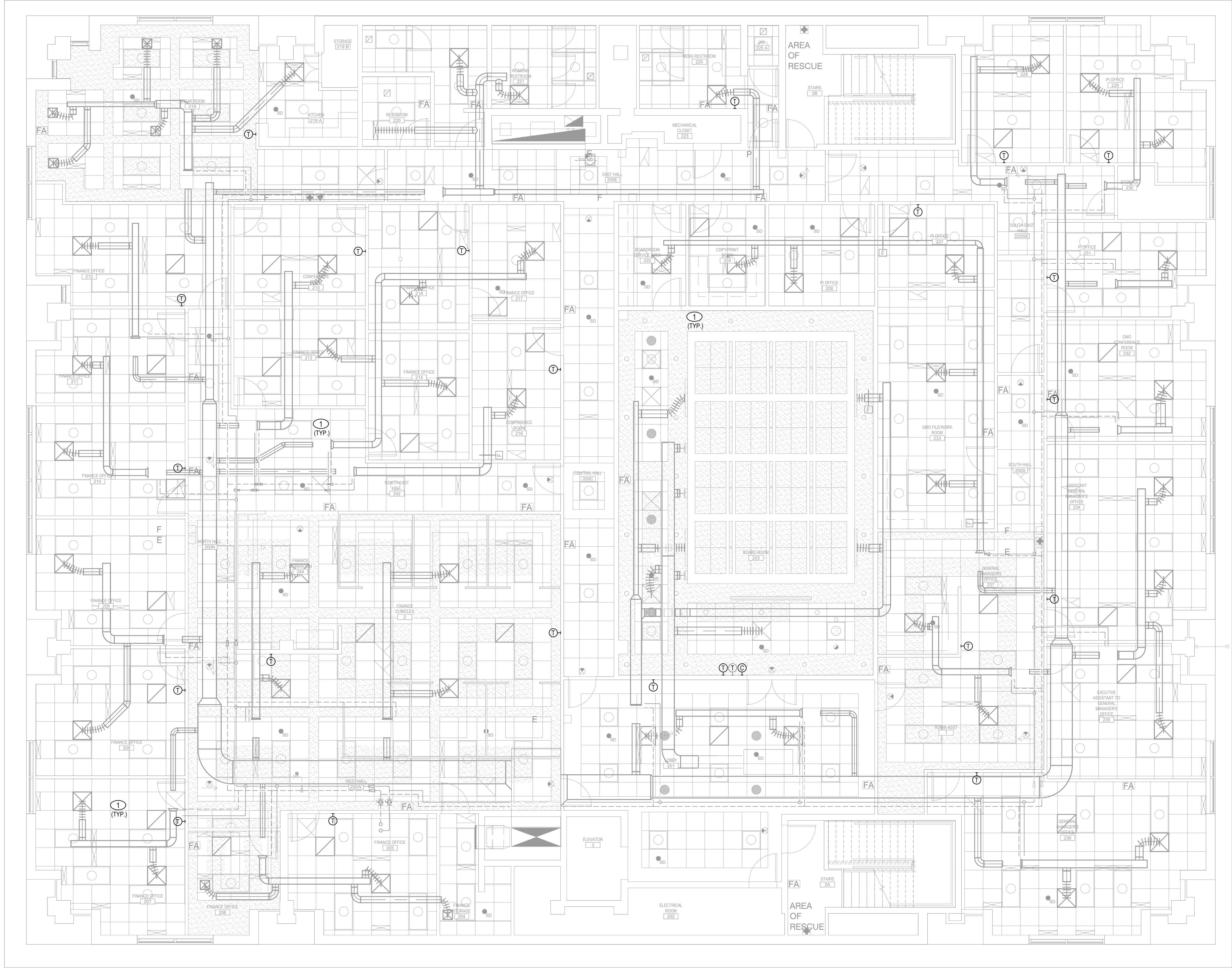
PROJECT NO.: 24-0006120
DESIGNED BY: ZAD
CHECKED BY: ZAD
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

SHEET NAME
ELECTRICAL
POWER PLAN -
LEVEL 4 - PHASE
II

SHEET NUMBER
E105

Architect: Davis Brody Bond, Inc. 300 West 10th Street, Suite 100, New York, NY 10038
3/20/2025 10:08:35 AM

1 ELECTRICAL LIGHTING PLAN - LEVEL 2
E202 3/16" = 1'-0"



SHEET NOTES

- A. REFER TO DRAWING E001 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
- B. CIRCUIT NUMBERS ARE DIAGRAMMATIC. EXACT NUMBERS SHALL BE DETERMINED IN FIELD AND BE REFLECTED ON RECORD DRAWINGS BY THE ELECTRICAL CONTRACTOR. THE ASSOCIATED CIRCUIT NUMBERS THAT ARE APPLIED TO EACH DEVICE AND PIECE OF EQUIPMENT INFERS INTERCONNECTING BRANCH CIRCUITRY. INTERCONNECTING BRANCH WIRING SHALL BE SIZED EQUAL TO HOME RUN UNLESS NOTED OTHERWISE.
- C. VOLTAGE DROP HAS BEEN CONSIDERED IN THE DESIGN OF ALL BRANCH CIRCUITRY AND FEEDERS ARE SIZED BASED ON THE ILLUSTRATE EQUIPMENT LAYOUT AND SHORTEST CONDUCTOR/RACEWAY ROUTING. THE EC IS RESPONSIBLE FOR ANY DEVIATIONS TAKEN THAT MAY INCREASE THE CONDUCTOR LENGTHS. BRANCH CIRCUITS LONGER THAN 75' FOR 120V FROM PANEL TO LAST OUTLET SHALL BE INCREASED A MINIMUM OF ONE SIZE ABOVE THAT SPECIFIED TO LIMIT VOLTAGE DROP TO LESS THAN 3%. FEEDERS SHALL FOLLOW SIMILAR GUIDELINES AND BE LIMITED TO 2% DROP.
- D. POWER BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT.
- E. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING POWER DEVICES TO REMAIN.

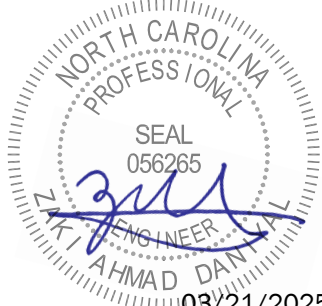
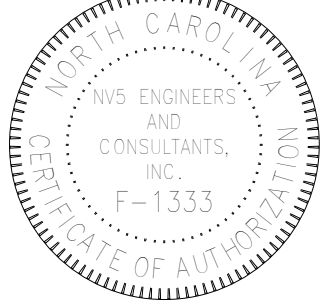
KEY NOTES

1. COORDINATE INSTALLATION OF NEW DUCTWORK AND PIPING WITH ARCHITECTURAL AND MECHANICAL DRAWINGS. CONTRACTOR TO CAREFULLY REMOVE ALL ELECTRICAL EQUIPMENT ON CEILING AT AREAS WHERE CEILING IS AFFECTED BY NEW DUCT AND NEW PIPING. INSTALLATION ELECTRICAL EQUIPMENT TO INCLUDE BUT NOT LIMITED TO LIGHT FIXTURES, LIGHTING CONTROL DEVICES, FIRE ALARM DEVICES AND LIFE SAFETY DEVICES ETC. ELECTRICAL EQUIPMENT TO BE REINSTALLED AT LOCATIONS SHOWN ONCE CEILING IS REWORKED AND REINSTALLED.

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CLIENT

CONSULTANT

PROJECT NAME

GUC ADMIN
BUILDING HVAC
UPGRADE

KEY PLAN



REVISION/ISSUANCE		
#	DESCRIPTION	DATE
1	CONSTRUCTION DOCUMENTS	03/21/25

PROJECT NO.: 24-0006120
DESIGNED BY: ZAD
CHECKED BY: ZAD
DATE: 03/21/2025
SCALE: 3/16" = 1'-0"

SHEET NAME

ELECTRICAL
LIGHTING
CEILING PLAN -
LEVEL 2

SHEET NUMBER

E202

4'-0" 8'-0" 16'-0"



E203

PROJECT NO.:	24-0006120
DESIGNED BY:	ZAD
CHECKED BY:	ZAD
DATE:	03/21/2025
SCALE:	3/16" = 1'-0"

Autodesk Docs/5594_24-0006120 - GUC Admin Building HVAC Upgrade MEP/23.rvt
3/20/2025 4:08:41 PM

Architect: David J. Bickel, AIA 0006-020 - GUC Admin Building HVAC Upgrade, MEP/25-04
3/20/2025 4:08:51 PM

PANEL: AC																			
PROJECT NUMBER: 24-000103				VOLTAGE: 480Y/277V, 3PH, 4W				BUS: 800A				LOCATION: SUPPLIED FROM: MCP							
				MAIN: 100 A MLO				NEMA RATING: Type 1				L=LONG CONTINUOUS							
				AC RATING: 1000				MOUNTING: SURFACE				N=NON-CONTINUOUS							
												R=DEMANDABLE RECEPTACLES							
												Motor = CONNECTED MOTOR							
CKT	TYPE	TRIP	POLE	LOAD DESCRIPTION			NOTES	A	B	C	NOTES	LOAD DESCRIPTION			POLE	TRIP	TYPE	CKT	
1	Power	50 A	3	SERVER ROOM UNIT 1 (UM)				10000	10000 VA			SERVER ROOM UNIT 2 (UM)			3	50 A	Power	2	
3	Power	50 A	3	SERVER ROOM UNIT 1 (UM)				10000	10000 VA			SERVER ROOM UNIT 2 (UM)			3	50 A	Power	4	
5	Power	50 A	3	SERVER ROOM UNIT 1 (UM)				10000	10000 VA			SERVER ROOM UNIT 2 (UM)			3	50 A	Power	6	
7	Power	50 A	3	SERVER ROOM UNIT 1 (UM)				10000	10000 VA			SERVER ROOM UNIT 2 (UM)			3	50 A	Power	8	
9	Power	20 A	3	WATER HEATER (UM)				3333	3333 VA	3333 VA		PUMP (UM)			3	20 A	Power	10	
11	Power	20 A	3	WATER HEATER (UM)				3333	3333 VA	3333 VA		PUMP (UM)			3	20 A	Power	12	
13	Power	20 A	3	WATER HEATER (UM)				3333	3333 VA	3333 VA		PUMP (UM)			3	20 A	Power	14	
15	Power	20 A	3	HEAT PUMP (UM)				3333	3333 VA	13333 VA		PERIMETER HEATER 2			3	20 A	Power	16	
17	Power	20 A	3	HEAT PUMP (UM)				3333	3333 VA	13333 VA		PERIMETER HEATER 2			3	20 A	Power	18	
19	Power	20 A	3	HEAT PUMP (UM)				3333	3333 VA	13333 VA		PERIMETER HEATER 2			3	20 A	Power	20	
21	Power	30 A	3	AHU-1 (UM)			-	0	3333 VA	0 VA		XM FAN			3	30 A	Power	22	
23	Power	30 A	3	AHU-1 (UM)			-	0	3333 VA	0 VA		XM FAN			3	30 A	Power	24	
25	Power	30 A	3	AHU-1 (UM)			-	0	3333 VA	0 VA		XM FAN			3	30 A	Power	26	
27	Power	30 A	3	AHU-1 (UM)			-	0	0 VA	0 VA	0 VA	-	SPARE			3	30 A	Power	28
29	Power	30 A	3	AHU-1 (UM)			-	0	0 VA	0 VA	0 VA	-	SPARE			3	30 A	Power	30
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33	Power	40 A	3	PANEL AC2 (UM)				10000	10000 VA			CORE FAN (UM)			3	40 A	Power	34	
35	Power	40 A	3	PANEL AC2 (UM)				10000	10000 VA			CORE FAN (UM)			3	40 A	Power	36	
37	Power	100 A	3	RTU-1				21267	21267 VA	0 VA		SPARE			3	100 A	Power	38	
39	Power	100 A	3	RTU-1				21267	21267 VA	0 VA		SPARE			3	100 A	Power	40	
41	Power	100 A	3	RTU-1				21267	21267 VA	0 VA		SPARE			3	100 A	Power	42	
43	Power	100 A	3	RTU-2				21267	21267 VA	0 VA		SPARE			3	100 A	Power	44	
45	Power	100 A	3	RTU-2				21267	21267 VA	0 VA		SPARE			3	100 A	Power	46	
47	Power	100 A	3	RTU-2				21267	21267 VA	0 VA		SPARE			3	100 A	Power	48	
49	Power	100 A	3	RTU-2				21267	21267 VA	0 VA		SPARE			3	100 A	Power	50	
51	Power	100 A	3	RTU-2			-	0	0 VA	0 VA	0 VA	-	SPARE			3	300 A	Power	52
53	Power	100 A	3	RTU-2			-	0	0 VA	0 VA	0 VA	-	SPARE			3	300 A	Power	54
				TOTAL CONNECTED LOAD:				193200 VA	193200 VA	193200 VA									
				TOTAL CURRENT:				364 A	364 A	364 A									
				LOAD TYPE				CONNECTED LOAD	DEMAND LOAD						PANEL TOTALS				
				Power				327000 VA	327000 VA										
												TOTAL CONNECTED LOAD:				238 VA			
																238 VA			
												TOTAL CONNECTED CURRENT:				364 A			
																364 A			
												TOTAL DEMAND CURRENT:				364 A			
																364 A			

PANEL: MDP

JOB: 24-0001-03

LOCATION: ELECTRIC ROOM 15A

FED FROM:

VOLTAGE: 480Y/277V, 3PH, 4W

BUS: 1000 A

PHASE: 3

MAINS: 1000A MCB

WIRE: 000

KWAGE: 03.000

CIRCUIT NUMBER	DESCRIPTION OF LOAD	APPARENT LOAD	POLES	CIRCUIT BREAKER FRAME	TRIP	NOTES
1	CEILING FAN (UM)	400 VA	3Ø/3P-A	60 A	40 A	
2	PNL 2A (UM)	500 VA	0 A	3	70 A	70 A
3	ELEVATOR (UM)	500 VA	0 A	3	100 A	100 A
4	PNL RP2A & RP3Ø (UM)	200 VA	0 A	3	100 A	100 A
5	PNL LP2A & LP3Ø (UM)	500 VA	0 A	3	100 A	100 A
6	PNL 3H (UM)	500 VA	0 A	3	125 A	175 A
7	PNL 1C & 4H (UM)	500 VA	0 A	3	200 A	300 A
8	TRIO (UM)	500 VA	0 A	3	40 A	40 A
9	PNL RP1A (UM)	500 VA	0 A	3	80 A	80 A
10	PNL GEN (UM)	500 VA	0 A	3	100 A	100 A
11	PNL RP2A & RP3Ø (UM)	500 VA	0 A	3	100 A	100 A
12	SPACE	—	—	3	—	—
13	AC (UM)	327.6 kVA	3Ø/3A	3	800 A	800 A
14						
15						
16						
17						
18						
19						
20						
TOTAL:		776.6 kVA	3Ø/3A			NOTES
ADDER:						
MINIMUM FEEDER CAPACITY:		776.6 kVA	3Ø/3A			

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