



OKLAHOMA CITY
COMMUNITY COLLEGE

SOLICITATION FOR BID

MAIN CAMPUS/MAIN BUILDING AIR HANDLER REPLACEMENT

SFB Number: 2-SFB-23-005
Submission Deadline Date/Time: July 13, 2022; 2:00 p.m. CST

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SOLICITATION FOR BIDS/BID NOTICE
MAIN CAMPUS/MAIN BUILDING AIR HANDLER REPLACEMENT
OKLAHOMA CITY COMMUNITY COLLEGE

Sealed bids will be received by Oklahoma City Community College (“OCCC”) for the Main Campus/Main Building Air Handler Replacement no later than the Bid Submission date and time indicated below. Due to State requirements for sealed bids, electronic delivery by email will not be accepted. All bids must be sealed and clearly marked with the Solicitation for Bids (SFB) Number and the Submission Deadline and Bid Opening Dates and Times on the outside of the bid envelope.

Bid documents and information concerning the solicitation may be accessed on the OCCC Purchasing Department Webpage at <https://www.occc.edu/purchasing/>. Requests for information or questions concerning the solicitation must be directed solely to the OCCC Director of Purchasing at the email address or telephone number provided below.

OCCC Project Number:	#2-SFB-23-005
Project Name:	Main Campus/Main Building Air Handler Replacement
Project Location:	7777 S. May Ave., Oklahoma City, OK 73159
Bid Documents:	https://www.occc.edu/purchasing/
Pre-bid Conference:	<u>Mandatory</u>
Day, Date, Time:	June 28, 2022; 2:00 p.m. Main
Location:	Building, Room 2N5
Masks encouraged	
Deadline for Questions from Bidders <i>(Questions must be submitted in writing only by email)</i>	July 1, 2022; 1:00 p.m. CST
Bid Submission Deadline Day, Date, Time:	July 13, 2022; 2:00 p.m. CST
Public Bid Opening Day, Date, Time:	July 13, 2022; 2:15 p.m. CST
Bid Opening Location:	Oklahoma City Community College John Massey Center, Room 131 7777 S. May Ave. Oklahoma City, OK 73159 Attn: Craig Sisco, Director of Purchasing
Contact Person:	Craig Sisco, Director of Purchasing michael.c.sisco@occc.edu

Bid Bond or Other Security:

For projects exceeding \$100,000, security in the form of a cashier’s check or certified check from a federally insured institution, a surety bond from a company authorized in Oklahoma, or irrevocable letter

of credit from a federally insured institution in the amount of five percent (5%) of the total bid must accompany the bid submission. After the bid opening, OCCC will release the bid securities except those of the three lowest bidders. The three lowest bid securities will be placed with OCCC until the contract is entered or cancelled. Afterward, OCCC will return the bid securities to the bidders.

Bid Documents – Bidders must use the complete set of Bidding Documents from the Purchasing Department Webpage. OCCC assumes no responsibility for errors or misrepresentation arising from use of incomplete Bid Documents.

Bid Forms – Bidders must use the bid form contained in this Bid Notice for bid submissions.

Addenda – OCCC will attempt to email Addenda notices to the bidders shown in OCCC records to have received bidding documents. Addenda and other information will additionally be located on the OCCC Purchasing Webpage at <https://www.occc.edu/purchasing/>. Bidders are responsible to check the Webpage to determine if addenda or additional information is posted. OCCC is not responsible for email notification to any bidder during the solicitation process when the solicitation information and updates are posted on the Purchasing Webpage. Therefore, bidders must review the Webpage for all bid information before bid submission.

Sealed Bid Envelope Label – All bids must be sealed with the following information label on the outside envelope. Improperly labeled bids may be excluded from consideration.

SFB No: 2-SFB-23-005

SFB Submission Deadline: July 13, 2022; 2:00 p.m. CST

Public Bid Opening: July 13, 2022; 2:15 p.m. CST

Bidder's Name: _____

Bidder's Address: _____

Project Title: Main Campus/Main Building Air Handler Replacement

Mail or Deliver this package to:

**Oklahoma City Community College
John Massey Center, Rm 140
7777 S. May Ave.
Oklahoma City, OK 73159
Attn: Craig Sisco, Director of Purchasing**



OKLAHOMA CITY
COMMUNITY COLLEGE

Bidder Document Checklist

All information and items listed below must be included in your bid submission.

Your bid may be excluded from consideration if any omissions are made.

- Provide company name, company contact, address, telephone number, Tax ID/FEIN, and email address on the form.
- Complete and sign the bid statement; if any questions do not apply, enter “None”.
- Complete each field in the form, including notice of addenda, base bid or total bid amount, and any alternate prices.
- Include the required five percent (5%) bid security. Copies are not acceptable. Checks must be either certified or cashier’s, and irrevocable letters of credit for bids must be provided on OCCC’s form.
- Check the OCCC Purchasing Department Webpage to ensure you are aware of, and acknowledge all addenda, and bid information at <https://www.occc.edu/purchasing>.
- Check pricing to verify each entry is correct.
- Include all documentation requested.
- Properly label the bid envelope as directed.

OCCC reserves the right to reject any or all bids.



OKLAHOMA CITY
COMMUNITY COLLEGE

Bid Form

Re: Bid #2-SFB-23-005

<p>To:</p> <p>Oklahoma City Community College Purchasing Department John Massey Ctr, Rm 140 7777 S. May Ave. Oklahoma City, OK 73159 Attn: Craig Sisco, Director of Purchasing</p> <hr/> <p>(Addenda Numbers, if any)</p>	<p>From:</p> <hr/> <p>(Company Name)</p> <hr/> <p>(Address)</p> <hr/> <p>(City, State, Zip)</p> <hr/> <p>(Telephone) (Tax No./EIN)</p> <hr/> <p>(Email Address)</p>
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ARTICLE 1: General.

1.1 The undersigned Bidder, who represents that Bidder is knowledgeable about the local area and conditions affecting the cost and performance of the Work, and being familiar with the Contract Documents, including the Solicitation for Bids, General Conditions, Special Conditions, Specifications, and Addendum Number(s) related to the Solicitation listed above, proposes to furnish all labor, materials and equipment necessary for the Project in accordance with specifications provided for the amounts listed below.

1.2 Bidder acknowledges that OCCC reserves the right to reject any and all bids. Bidder agrees that this bid may not be withdrawn for a period of thirty (30) days after the Bid Opening. Work is to start within ten (10) days after receipt of Notice to Proceed, unless otherwise agreed in writing.

1.3 If the bid exceeds \$100,000, it shall be accompanied by a bid security in the form of a certified check or cashier's check from a federally insured institution, surety bond from a company authorized to do business in the State of Oklahoma, or irrevocable letter of credit from a federally insured institution for five percent (5%) of the total bid amount, conditioned upon the Bidder contracting with OCCC under the terms of the bid. It is agreed that said bid security of the successful bidder will constitute liquidated damages, and not a penalty for the failure of the bidder to enter into a contract in accordance with this bid.

ARTICLE 2: Compliance.

2.1 The Bidder certifies that:

2.1.1 Bidder is an Equal Employment Opportunity Employer and does not discriminate in any business or employment practices;

2.1.2 Bidder, and all sub-contractors and suppliers performing work on the Project, will comply with the provisions of the Oklahoma Taxpayer and Citizen Protection Act of 2007 and participate in the Status Verification System defined in the Oklahoma Statutes, Title 25, §1312;

2.1.3 Bidder will comply with all applicable laws concerning construction requirements for OCCC as a public institution for higher education in the State of Oklahoma; and

2.1.4 Bidder will comply with the Governor’s Executive Order prohibiting use of all tobacco products on State property, including OCCC properties and buildings.

ARTICLE 3: Bids. (SPECIFICATIONS)

3.1 Oklahoma City Community College is accepting bids for a Main Campus/Main Building Air Handler and associated variable air volume (VAVs) replacement project. The replacement project will address the removal of existing air handlers and the installation of new units and their associated VAVs.

- Exhibit A – Detailed Electrical Specifications
- Exhibit B – Detailed Mechanical Specifications
- Exhibit C – Academic Calendar 2021-2022
- Exhibit D – Academic Calendar 2022-2023
- Exhibit E – SPECS 2022-05-16 (COMBINED DELIVERABLE)
- Exhibit F – Contract Provisions for Non-Federal Entity Contracts Under Federal Awards

3.2 Mandatory Pre-Bid Meeting

A **mandatory** pre-proposal conference will be held. The purpose of this conference is to provide an opportunity for potential contractors to ask OCCC representatives questions regarding terms, conditions, and specifications of the bid. Failure of potential contractors to attend this conference will preclude their ability to submit proposals under this bid. Notifications of attendance must be made prior to the pre-proposal conference to the contact listed below.

Location: Oklahoma City Community College
Main Building, Room 2N5
7777 South May Avenue
Oklahoma City, OK 73159

Date: Tuesday, June 28, 2022
Time: 2:00 p.m. CST
Point of Contact: Craig Sisco, Director of Purchasing
michael.c.sisco@occc.edu

3.3 **Contractor Information**

The successful contract shall have or have had verifiable and successful similar project contract of like size and like services culminating in at least five years of experience.

As part of the Bid submission, the contractor must furnish a list, which includes the company name, contact person, address, telephone and email address of at least three (3) references where the contractor has performed similar work. Some of the references must be of like size and services.

3.4 **Considerations and Requirements**

In the provided bid, each contractor shall provide and be aware of the following:

- Considerations as it relates to Oklahoma City Community College's determination of the lowest responsible bidder will include:
 - Bid Cost
 - Number of project calendar days
 - Supplied project schedule
 - Supplied project execution plan
- Contractors are to review Academic Calendars provided as Exhibits (C & D) and develop their project schedule and project execution plan in a fashion that will minimize any impact to the College's educational process
- Liquidated damages will incur at \$1,500.00 per day past the provided duration
- The selected contractor will receive a Notice to Begin. Once received the project duration as provided in the pricing summary will begin. Liquidated damages will be calculated at \$1,500.00 per day past the provided project calendar days
- The provided project execution plan shall include, but is not limited to:
 - A breakdown of the project execution strategy including specifics related to all stages of the project:
 - Project Initiation
 - Project Planning
 - Project Execution
 - Project Monitoring
 - Project Closure
 - The lifting of air handlers on to the roof of the OCCC Main Building. Consideration should be addressed as needed/necessary for, but not limited to:
 - How the units will be lifted
 - Street Closures
 - Communications
 - Safety Protocols
 - Perimeter Protection
 - Additional Logistics
 - Additional Safety Protocols

- Specific details and strategy as it relates to minimizing the educational impact to Oklahoma City Community College utilizing the provided academic calendar exhibits including in the Bid for the duration of the project.
- The College reserves the right to extend the duration upon request of the Contractor due to unforeseen circumstances impeding project progress
- The Contractor is required to have representation on-site while project work is being performed. Additionally, the Contractor shall also have representation on-site when any sub-contractors are being utilized
- Hours of access:
 - Contractor shall have access for project performance Monday-Thursday, 6:00 a.m. to 9:00 p.m.; Friday, 6:00 a.m. to 6:00 p.m. or as defined through seasonal operating hours schedules
 - Work may be performed on Saturdays with a 48-hour prior request and approval if determined necessary by the College.

3.5 Pricing Summary

1. Expected Duration of Project (Calendar Days): _____
2. Bid: \$ _____
3. **TOTAL BID PRICE:** \$ _____
4. Is Contractors' Project Schedule included? Yes / No
5. Is Contractor's Project Execution Plan Included? Yes / No
6. Include estimated of total project completion percentage and estimated total invoiced amounts by the following dates:
 - December 31, 2022
 - March 31, 2023
 - June 30, 2023
 - September 30, 2023
 - December 31, 2023

ARTICLE 4: Unit Prices for Concealed or Unknown Conditions.

- 4.1 Refer to General Construction Contract Conditions, Paragraph 4.3.6 "Claims for Concealed or Unknown Conditions".
- 4.2 In the event additional work is required for repair or remediation of concealed or unknown conditions, Unit Prices shall be submitted by the bidder for the purpose of establishing sums to be added to or deducted from the Contract. Unit prices shall cover the cost of materials, labor required, demolition, equipment, incidentals and services, overhead and profit required to complete any necessary additional work.

4.3 Unit Prices shall be within a competitive range of the then current market value. OCCC shall be the sole judge of the competitive range determination as reasonably determined by reference to pricing in the industry.

4.4 A Change Order shall be submitted and executed before any work using unit prices is started.

ARTICLE 5: Statements.

5.1 Non-collusion Statement.

For the purposes of a competitive bid for a public construction contract, the undersigned, being first duly sworn, certifies that:

5.1.1 I am the duly authorized agent of the Bidder submitting the competitive bid which is attached to this statement, for the purpose of certifying the facts pertaining to the existence of collusion among bidders and between bidders and state officials or employees, as well as facts pertaining to the giving or offering of things of value to government personnel in return for special consideration in the letting of any contract pursuant to the bid to which this statement is attached;

5.1.2 I am fully aware of the facts and circumstances surrounding the making of the bid to which this statement is attached and have been personally and directly involved in the proceedings leading to the submission of such bid; and

5.1.3 Neither the Bidder nor anyone subject to the bidder's direction or control has been a party:

- a. to any collusion among bidders in restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding,
- b. to any collusion with any state official or employee as to quantity, quality or price in the prospective contract, or as to any other terms of such prospective contract, nor
- c. in any discussions between bidders and any state official concerning exchange of money or other thing of value for special consideration in the letting of a contract.

5.2 I certify, if awarded the contract, whether competitively bid or not, neither the contractor nor anyone subject to the contractor's direction or control has paid, given or donated or agreed to pay, give or donate to any officer or employee of the State of Oklahoma any money or other thing of value, either directly or indirectly, in procuring the contract to which this statement is attached

5.3 Business Relationship Statement.

5.3.1 I further certify that the nature of any partnership, joint venture or other business relationships presently in effect or which existed within one (1) year prior to the date of this statement with the Architect, Engineer, or other party of the project is:

(If none, so state; use additional sheet if necessary.)

5.3.2 That any such business relationship presently in effect or which existed within one (1) year prior to the date of this statement between any officer or director of the bidding company and any officer or director of the architectural or engineering firm or other party to the project is:

(If none, so state; use additional sheet if necessary.)

5.3.3 And that the names of all persons having any such business relationships and the positions they hold with their respective companies or firms are:

(If none of the business relationships herein above mentioned exist, then a statement to that effect. Use additional sheet if necessary.)

ARTICLE 6: Federal Requirements

6.1 All or part of this project shall be funded with federal funds. Any resulting contract from this SFB shall contain provision in Exhibit F – Contract Provisions for Non-Federal Entity Contracts Under Federal Awards.

BIDDER:

If awarded a contract, the Bidder affirms that the work will be carried out in conformance with the contract requirements and that all invoices submitted for payment will reflect a true and accurate accounting of the work completed. I affirm that I have read and acknowledge all addenda issued in connection with this Bid, if any.

I solemnly swear or affirm, under penalty of perjury, that the foregoing is true and correct.

(Bidder Signature)

(Bidder Printed Name)

(Bidder Printed Title)

(Date)



OKLAHOMA CITY COMMUNITY COLLEGE

Bidder Instructions

ARTICLE 1: Definitions.

- 1.1 **Bidding Documents** include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the advertisement or invitation to bid (Solicitation for Bids), Instructions to Bidders, supplementary instructions to bidders, the bid form(s), and any other sample bidding and contract forms, and the proposed contract documents including any Addenda issued prior to the receipt of Bids.
- 1.2 **Definitions** set forth in the General Conditions of the Contract for Construction, or in other Proposed Contract Documents apply to the Bidding Documents.
- 1.3 **Addenda** are written or graphic instruments issued by the OCCC, which, by additions, deletions, clarifications, or corrections, modify or interpret the Bidding Documents.
- 1.4 A **Bid** is a complete and properly executed proposal to do the Work or designated portion thereof for the sums stipulated therein, submitted in accordance with the Bidding Documents.
- 1.5 The **Base Bid** is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents, to which Work may be added or deleted by sums stated in the Alternate Bids.
- 1.6 An **Alternate Bid** (or Alternate) is an amount stated in the Bid to be added to or deducted, or does not change, the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.
- 1.7 A **Unit Price** is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, as described in the Bid Documents.
- 1.8 A **Bidder** is a person or entity that submits a Bid and meets the requirements set forth in the Bidding Documents.
- 1.9 The **Website** of OCCC is www.occc.edu. The Purchasing Department **Webpage** is <https://www.occc.edu/purchasing/>.
- 1.10 The **Owner** is Oklahoma City Community College (OCCC), 7777 S. May Ave., Oklahoma City, OK 73159.
- 1.11 The **Consultant** is the Licensed Architect, Licensed Landscape Architect, Registered Professional Engineer, or Registered Land Surveyor under contract to OCCC for the purpose of designing and monitoring the construction of the project acting in the capacity as the OCCC's Representative; if OCCC does not contract for a Consultant, OCCC will designate an OCCC employee as the Consultant.

ARTICLE 2: Pre-bid Conference.

- 2.1 The Solicitation for Bids will indicate the date, time, and place for a pre-bid conference if one is to be held.
- 2.2 In some instances, a mandatory pre-bid conference will be announced. In such instances, each prospective Bidder must be present at the meeting or represented by a full-time company employee or an independent contractor authorized to represent the company. Failure to comply will disqualify that Bidder. Attendees must arrive on time and sign in no later than fifteen minutes after the scheduled meeting time. Exceptions to the sign-in requirement may be granted by the OCCC Project Manager for unusual or unforeseen conditions, in the OCCC Project Manager's sole discretion.
- 2.3 **Verbal communications at any pre-bid meeting are non-binding.** All clarifications or changes to the bidding documents will be memorialized in written addenda. Such addenda will be posted on the OCCC Purchasing Department Webpage. Bidders are responsible to check the Webpage for all updates and addenda.

ARTICLE 3: Bidder's Representations and Prequalification.

- 3.1 By submitting a Bid, the Bidder represents that:
- 3.1.1 The Bidder has read and understands the Bidding Documents;

3.1.2 The Bidder has toured the site, is familiar with the local conditions affecting performance of the work, and has a plan to implement the requirements of the proposed contract documents under existing site conditions; and

3.1.3 The submitted Bid is based upon the materials, systems and equipment required by the Bidding Documents without exception.

3.2 **Pre-qualification of Bidders and Special Requirements.** The Solicitation for Bids / Bid Notice indicates the General Contractors, Sub-Contractors, and Material Suppliers that require pre-qualification in order to bid on the project. When designated on the Solicitation for Bids / Bid Notice, the General Contractors, Sub- Contractors, and Material Suppliers shall submit a completed OCCC Form, Contractor's Qualification Statement, describing required specialized experience, for approval by the Owner, fourteen (14) calendar days prior to the Bid Date unless stated otherwise. Printed or electronic forms are available on request from the Owner.

ARTICLE 4: Bidding Documents.

4.1 Copies.

4.1.1 Bidders may obtain complete sets of the Bidding Documents from the OCCC Purchasing Department Webpage.

4.1.2 Bidders shall ensure submission of complete sets of Bidding Documents. Bidders shall be responsible for any omissions or errors due to submission of incomplete Bidding Documents or sets thereof.

4.2 Interpretation or correction of Bidding Documents:

4.2.1 Bidders shall promptly notify OCCC of any ambiguity, issue or mistake that may be discovered within the Bidding Documents or related to the site.

4.2.2 Any change, addition, clarification, or other amendment concerning the Bidding Documents will be in writing and posted on the Purchasing Department Webpage in an Addendum. Communications in any other form concerning any change, addition, clarification, or other amendment to the Bidding Documents shall not be binding in any manner and Bidders may not rely on such communications.

4.3 Substitutions.

4.3.1 When name brands are used to describe materials, products, or equipment, the name brands are used only to establish a standard of required function, dimension, appearance and quality to be met by any properly proposed substitution.

4.3.2 No substitutions for bidding will be considered unless written request for approval has been received by the OCCC at least ten (10) calendar days prior to the date for receipt of Bids, if not otherwise stated in the Bidding Documents. Each request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and any other information necessary for an evaluation. A statement setting forth any changes in any other materials, equipment or other work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. OCCC's decision of approval or disapproval of a proposed substitute shall be final.

4.3.3 If OCCC approves any proposed substitution prior to receipt of Bids, such approval will be set forth in a written Addendum and published on the Webpage. Approvals in any other form shall not be valid and Bidders may not rely upon them.

4.3.4 Substitutions after the contract award shall not be authorized unless expressly addressed the contract documents.

4.4 Addenda.

4.4.1 Addenda will be posted on the OCCC Purchasing Department Webpage. Bidders are responsible to check the Webpage to ensure they have all information before submitting bids.

4.4.2 Addenda will not be issued any later than one business day after the Deadline for Bidder Questions contained on the Bid Notice, except for withdrawal of the request for bids or a change to the Deadline for Bid Submission or Bid Opening dates.

4.4.4 Bidders are responsible to ensure they have reviewed all Addenda and acknowledge review on the Bid Form.

ARTICLE 5: Bidding Procedure.

5.1 Completion of Bids.

5.1.1 Bidders shall complete all blanks on the bid forms.

5.1.3 Sums shall be written in both words and figures, and if they are inconsistent, the amount written in words shall govern.

5.1.4 Interlineation, alteration or erasure of the Bidder's entries on the bid form is not permitted unless the Bidder initials them.

5.1.5 All requested Alternates shall be bid. If no change to the Base Bid is required, enter "No Change".

5.1.6 Each copy of the Bid shall be signed by the person legally authorized to bind the Bidder to a contract.

5.2 **Bid Security.**

5.2.1 Each Bid must be accompanied by a certified or cashier's check, irrevocable letter of credit, or bid bond for five percent (5%) of the total amount of the Bid and all Alternates (collectively, Bid Securities) as a guarantee that, if awarded the contract, the Bidder will execute the contract and furnish bonds and insurance as required herein. An Irrevocable Bid Letter of Credit used as bid security must be issued by a financial institution insured by the Federal Deposit Insurance Corporation or the Federal Savings and Loan Insurance Corporation on a form obtained from OCCC. Bonds used as Bid Securities must be issued by companies authorized to conduct business in Oklahoma. All Bid Securities must be delivered to the Purchasing Department of OCCC prior to the Bid Submission Deadline. OCCC reserves the right to hold the bid security of the three (3) lowest Bidders until the successful Bidder has executed the contract and furnished the required bonds and proof of insurance. No bid security is required if the total of the Base Bid and Alternates is One Hundred Thousand Dollars (\$100,000.00) or less.

5.2.2 Failure of the successful Bidder to enter into a contract within the time specified in 5.2.3 of these instructions shall result in forfeiture to OCCC of the cost of republication of Notice to Bidders, all actual expenses incurred by reason of the Bidder's default and the difference between the low Bid of the defaulting Bidder and the amount of the bid of the Bidder to whom the contract is subsequently awarded, but not to exceed the amount of the Bid Security placed with OCCC.

5.2.3 An extension of sixty (60) days may be given to the normal twenty (20) days permitted Bidders to return their contracts when the Bidder experiences issues in obtaining bonds. The Bidder must submit a written request before OCCC may authorize any extension.

5.3 **Submission of Bids.**

5.3.1 All Bids must be submitted by mail or in person to the OCCC Purchasing Department, John Massey Center, Rm 140, 7777 S. May Ave., Oklahoma City, OK 73159. No bids will be accepted electronically. The Bid Security described above must be included with the Bid and delivered to the OCCC Purchasing Department no later than the Bid Submission Deadline.

5.3.2 The Bidder shall assume full responsibility for timely completion of the bid submission.

5.3.3 Bids received more than ninety-six (96) hours before, excluding weekends and holidays, as well as Bids received after the time set for submission of Bids, will not be considered and will be excluded as non-responsive.

5.4 **Modification, withdrawal or cancellation of Bids.**

5.4.1 A Bid may not be modified, withdrawn or canceled by the Bidder after the time and date designated for the receipt of Bids, and each Bidder so agrees in submitting a Bid.

5.4.2 Withdrawn Bids may be resubmitted up to the time designated for the submission of Bids provided they are in complete conformance with these Instructions to Bidders.

ARTICLE 6: Consideration of Bids.

6.1 Bids will be opened publicly immediately after the time set for Bid Openings at Oklahoma City Community College, 7777 S. May Ave., John Massey Center, Rm 131, Oklahoma City, OK 73159. The Bids will be read aloud and abstracted.

6.2 **Rejection of Bids.**

6.2.1 OCCC has the right to reject any or all Bids and to reject a Bid not accompanied by any required bid security, or by other data required by the Bidding Documents, or to reject a Bid which is in any way incomplete or irregular.

6.2.2 OCCC will reject any Bid that is not signed by the authorized representative of the Bidder or does not contain the certification included in the Bidding Documents. The certification must be properly signed by the Bidder.

6.2.3 OCCC may reject bids that are materially unbalanced as non-responsive. A bid is materially unbalanced when it contains prices significantly less than cost for some work and prices which are significantly higher in relation to cost for other work. Further, if reasonable doubt exists concerning whether a bid will actually result in the lowest overall cost to OCCC or if a bid is so unbalanced that it appears to require advance payment, such bids may, and likely will be, rejected.

6.3 Award of contract.

6.3.1 It is the intent of OCCC to award a contract to the lowest responsible Bidder provided the Bid was submitted in accordance with the requirements of the Bidding Documents and does not exceed the OCCC funds available. OCCC shall have the right to waive any informality or irregularity in any Bid or Bids received and to accept the Bid or Bids that are in the best interest of OCCC.

6.3.2 OCCC has the right to accept Alternates in any combination and determine the lowest responsible Bidder from the sum of the Base Bid and/or Alternates that may be accepted.

6.3.3 Time is of the essence in all OCCC work.

ARTICLE 7: Surety Bonds.

7.1 Bond requirements.

7.1.1 All bonds are for the full value of the contract and shall be issued by a surety company authorized by the Oklahoma Insurance Department to do business in the State of Oklahoma and approved by OCCC.

7.1.2 A bond is required for all contracts with a value exceeding One Hundred Thousand Dollars (\$100,000.00) that includes coverage for (1) Performance - to insure the completion of the work in accordance with the contract documents in the time stipulated; (2) Defect - to provide for defects in construction or materials for a period of one (1) year from the date of acceptance of the completed work; and (3) Payment - to assure OCCC is protected from the actions of subcontractors, suppliers and employees for unpaid debts of the contractor.

7.1.3 All bonds must be on the forms prescribed and issued by OCCC to the successful Bidders with the contract.

7.1.4 Irrevocable Letters of Credit may be used as a substitute for the bonds required in 7.1.2 of these instructions. The letters of credit must be issued by a financial institution insured by the Federal Deposit Insurance Corporation or the Federal Savings and Loan Insurance Corporation on forms obtained from OCCC.

ARTICLE 8: Insurance Requirements.

8.1 The contractor shall carry on his work in accordance with the Worker's Compensation Act, Title 85A of the Oklahoma Statutes, and shall not reject the provisions thereof during the life of the contract. A certificate of coverage must be returned with the contract.

8.2 General Liability to include contractual liability and Automobile Liability insurance in the amount of not less than \$100,000/\$300,000 are required during the life of the contract.

8.3 Builder's Risk insurance of not less than \$50,000/\$100,000 shall be carried by the contractor during the life of the contract.

8.4 Certificates of all required coverages must be returned with the contract.

ARTICLE 9: Form of Contract Agreement.

9. A sample of the contract form to be used as the agreement between OCCC and the successful Bidder is contained in the Bidding Documents. Bidder substitutions, changes, alterations or interlineation to the form of the contract are prohibited.

ARTICLE 10: Labor.

10. The Contractor shall comply with all State and Federal Laws in the employment and payment of labor.

ARTICLE 11: Documents of Construction.

11. Any additional sets of plans and specifications will be the responsibility of the Contractor.

END OF INSTRUCTIONS TO BIDDER



OKLAHOMA CITY COMMUNITY COLLEGE

General Construction Contract Conditions

ARTICLE 1: General Provisions.

1.1 Basic Definitions.

1.1.1 **The Contract Documents.** The Contract Documents consist of the agreement between OCCC and the Contractor (hereinafter called the Contract), Conditions of the Contract (General, Supplementary and other Conditions), Drawings and Specifications, along with Addenda issued prior to execution of the Contract, and other documents listed in the Contract and Change Orders issued after execution of the Contract. A Change Order is a written modification of the Contract and must be approved by the Board of Regents of Oklahoma City Community College and signed by both parties.

1.1.2 **The Contract.** The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties thereto and supersedes prior negotiations, representations or agreements, either written or oral. The Contract shall be amended or modified only by a Change Order. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Consultant, if any, and Contractor, (2) between the Owner and a Subcontractor or Sub-subcontractor or (3) between any persons or entities other than the Owner and Contractor. The Consultant shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Consultant's duties.

1.1.3 **The Work.** The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

1.1.4 **The Project.** The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner or by separate Contractors.

1.1.5 **The Drawings.** The Drawings are the graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location and dimensions of the Work, and includes plans, elevations, sections, details, schedules, diagrams and drawing notes.

1.1.6 **The Specifications.** The Specifications are located in the Project Manual and are that portion of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards and workmanship for the Work, and performance of related services. Where there is a discrepancy between the Drawings and the Specifications, the Specifications will take precedence. Such discrepancies must be brought to the attention of the Owner's Representative (Consultant) and the Owner before execution of any work related to the discrepancies.

1.2 Execution, Correlation and Intent.

1.2.1 The Contract Documents shall be signed by the Owner and Contractor as provided in the Contract.

1.2.2 Execution of the Contract by the Contractor is a representation that the Contractor has toured the site, is acquainted with local conditions affecting the Work to be performed, and has considered the impact of personal observations on completing the requirements of the Contract Documents.

1.2.3 The Contract Documents are to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the intended results.

1.2.4 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

1.2.5 Unless otherwise stated in the Contract Documents, words which have well known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

1.3 **Ownership and Use of Drawings and Specifications.**

1.3.1 The Drawings, Specifications and other documents prepared by OCCC or its Consultant are the property of OCCC. The Contractor may retain one contract record set. Neither the Contractor nor any Subcontractor, Sub-subcontractor or material or equipment supplier shall own or claim a copyright in the Drawings, Specifications and other documents prepared by the Consultant. All copies of them, except the Contractor's record set, shall be returned or suitably accounted for to the Owner, on request, upon completion of the Work. The Drawings, Specifications and other documents prepared by the Consultant, and copies thereof furnished to the Contractor, are for use solely with respect to this Project. They are not to be used by the Contractor or any Subcontractor, Sub-subcontractor or material or equipment supplier on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner. The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are granted a limited license to use and reproduce applicable portions of the Drawings, Specifications and other documents appropriate to and for use in the execution of their Work under the Contract Documents.

1.3.2 The Contractor shall provide all copies of the Drawings and Project Manuals required to complete the Work. The Owner will provide an electronic copy of the documents to the reproduction company for printing purposes.

1.4 Capitalization. Terms capitalized in these General Conditions include those which are (1) specifically defined or (2) the titles of numbered articles and identified references to Paragraphs, Subparagraphs and Clauses in the document.

1.5 Interpretation. In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an", but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

ARTICLE 2: Owner.

2.1 **Definition.** The Owner is Oklahoma City Community College. The term "Owner" means the Owner or the Owner's authorized representative.

2.2 **Owner's Right to Stop Work.** If the Contractor fails to correct Work which is not in accordance with the requirements of the Contract Documents as required by Paragraph 12.2 or persistently fails to carry out Work in accordance with the Contract Documents, the Owner, by written order, may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Subparagraph 6.1.3.

2.3 **Owner's Right to Carry Out the Work.** If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a seven-day period after receipt of written notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may after such seven-day period give the Contractor a second written notice to correct such deficiencies within a second seven-day period. If the Contractor within such second seven-day period after receipt of such second notice fails to commence and continue to correct any deficiencies, the Owner may, without prejudice to other remedies the Owner may have, correct such deficiencies. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the cost of correcting such deficiencies, including compensation for the Consultant's additional services and expenses made necessary by such default, neglect or failure. If payments then or thereafter due the Contractor are not sufficient to cover such payments, the Contractor shall pay the difference to the Owner.

2.4 **Owner's Right to Reject Work.** The Owner shall have the authority to reject Work that does not conform to the Contract Documents.

2.5 **Owner's Right to Approve Payment Applications.** The Owner shall have the right to review, evaluate and approve or reject Applications for Payment and Certificates for Payment.

ARTICLE 3: Contractor.

3.1 **Definition.** The Contractor is the person or entity identified as such in the Contract and is referred to throughout the Contract Documents as if singular in number. The term "Contractor" means the Contractor or the Contractor's authorized representative.

3.2 **Review of Contract Documents and Field Conditions by Contractor.**

3.2.1 The Contractor shall carefully study and compare the Contract Documents with each other and shall at once report to the Consultant or Owner any errors, inconsistencies or omissions discovered. The Contractor shall not be liable to the Owner or Consultant for damage resulting from errors, inconsistencies or omissions in the Contract Documents unless the Contractor recognized such error, inconsistency or omission and knowingly failed to report it to the Consultant. If the Contractor performs any construction activity knowing it involves a recognized error, inconsistency or omission in the Contract Documents without such notice to the Consultant, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

3.2.2 The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies or omissions discovered shall be reported to the Consultant at once.

3.3 **Supervision and Construction Procedures.**

3.3.1 The Contractor shall supervise and direct the Work using the Contractor's best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless Contract Documents give other specific instructions concerning these matters.

3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons performing portions of the Work under a contract with the Contractor.

3.3.3 The Contractor shall not be relieved of obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Consultant in the Consultant's administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

3.3.4 The Contractor shall be responsible for inspection of portions of Work already performed under this Contract to determine that such portions are in proper condition to receive subsequent Work.

3.4 **Labor and Materials.**

3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

3.4.2 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Contract. The Contractor shall not permit employment of unfit persons or persons not skilled in tasks assigned to them.

3.5 **Warranty.** The Contractor warrants to the Owner and Consultant that materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects not inherent in the quality required or permitted, and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Consultant, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

3.6 **Taxes.**

3.6.1 **Bid Pricing to Reflect OCCC's Tax Exempt Status.** Bid pricing shall be exclusive of taxes. OCCC is exempt from taxes, including State Sales Tax, Property (Ad Valorem) Tax, and Federal Excise Tax. The applicable sales tax exemption authority for public contracting is under the Oklahoma Tax Code, title 68, subsection 1356.10 of the Oklahoma Statutes and the project is sales tax exempt.

3.7 **Permits, Fees and Notices.**

3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for permits, fees, licenses and inspections necessary for proper execution and completion of the Work which are customarily secured after execution of

the Contract and which are legally required when Bids are received. Building permits from local municipalities are not required for Work on OCCC owned lands except where the Work requires connection to utilities owned by the local municipality.

3.7.2 The Contractor shall comply with and give notices required by laws, ordinances, rules, regulations and lawful orders of public authorities bearing on performance of the Work.

3.7.3 It is not the Contractor's responsibility to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, building codes, and rules and regulations. However, if the Contractor observes that portions of the Contract Documents are at variance therewith, the Contractor shall promptly notify the Consultant and Owner in writing, and necessary changes shall be accomplished by appropriate Change Order.

3.7.4 If the Contractor performs Work knowing it to be contrary to laws, statutes, ordinances, building codes, and rules and regulations without such notice to the Consultant and Owner, the Contractor shall assume full responsibility for such Work and shall bear the attributable costs.

3.8 **Allowances.**

3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities against which the Contractor makes reasonable objection.

3.8.2 Unless otherwise provided in the Contract Documents:

a. materials and equipment under an allowance shall be selected promptly by the Owner to avoid delay in the Work.

b. allowances shall cover the cost to the Contractor of materials and equipment delivered at the site, tax exempt, and less applicable trade discounts.

c. Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum and not in the allowances.

d. Whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order.

3.9 **Superintendent.** The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The Contractor shall submit the name and experience qualifications of the proposed superintendents to the Owner for approval. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor. Important communications shall be confirmed in writing. Other communications shall be similarly confirmed on written request in each case.

3.10 **Contractor's Construction Schedule.**

3.10.1 Prior to the Work Order or Notice to Proceed being issued, the Contractor shall prepare and submit for the Owner's and Consultant's information a "90 Day Construction Schedule" which shall be used to monitor the progress of the Work during the first ninety (90) calendar days of the Contract. During this ninety-day period, the Contractor shall prepare and submit the "Construction Schedule" for the entire project, including the "90-day Project Schedule", which shall be used to monitor the remainder of the Work. The overall duration of the "Construction Schedule" shall coincide with and shall not exceed the time limits specified in the Contract Documents. During construction, if the progress of the Work does not meet the "Construction Schedule" the Contractor shall revise and resubmit the schedule for the delayed activities within 21 days of any delayed activity. Resubmitted schedules shall indicate the revised times for each activity and shall not exceed the time limits specified in the Contract Documents and any approved Change Orders. Failure to resubmit the delayed activity or maintain a current "Construction Schedule" shall be considered a breach of the Contract.

3.10.2 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Consultant.

3.10.3 Failure of the Contractor to construct the Work in accordance with the "90-Day Construction Schedule" or the "Construction Schedule" shall be considered a substantial breach of the Contract Documents and the Owner may terminate the Contract in accordance with Section 14.2. All "Float" time in the "Construction Schedule" shall be available to the Owner for the Owner's use.

3.10.4 The Contractor shall prepare and keep current, for the Consultant's or Owner's approval, a schedule of submittals that is coordinated with the Contractor's "Construction Schedule" and allows the Consultant reasonable time to review submittals.

3.11 Documents and Samples at the Site.

3.11.1 The Contractor shall maintain at the site for the Owner one record copy of the Drawings, Specifications, Addenda, Change Orders and other Contract Documents, in good order and marked currently to record changes and selections made during construction and, in addition, approved Shop Drawings, Product Data, Samples and similar required submittals. These shall be available to the Consultant and shall be delivered to the Consultant for submittal to the Owner upon completion of the Work.

3.11.2 Additionally, the Contractor shall maintain at the site the Drawings that have been stamped and approved by the State Fire Marshal. This approved set of Drawings is only for the use of the State Fire Marshal's office.

3.12 Shop Drawings, Product Data and Samples.

3.12.1 Shop Drawings are drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.

3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

3.12.3 Samples are physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

3.12.4 Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of their submittal is to demonstrate, for those portions of the Work for which submittals are required, the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents. Review by the Consultant is subject to the limitations of Subparagraph 4.2.7.

3.12.5 The Contractor shall review, approve and submit to the Consultant Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate Contractors. Submittals made by the Contractor that are not required by the Contract Documents may be returned without action.

3.12.6 The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Consultant. Such Work shall be in accordance with approved submittals.

3.12.7 By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

3.12.8 The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Consultant's approval of Shop Drawings, Product Samples or similar submittals unless the Contractor has specifically informed the Consultant in writing of such deviation at the time of submittal and the Consultant has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Consultant's approval thereof.

3.12.9 The Contractor shall direct specific attention, in writing, or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Consultant on previous submittals.

3.12.10 Informational submittals upon which the Consultant is not expected to take responsive action may be so identified in the Contract Documents.

3.12.11 When professional certification of performance criteria of materials, systems or equipment is required by the Contract Documents, the Consultant shall be entitled to rely upon the accuracy and completeness of such calculations and certifications.

3.13 Use of Site. The Contractor shall confine operations at the site to areas permitted by law, ordinances, permits and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

3.14 Cutting and Patching.

3.14.1 The Contractor shall be responsible for cutting, fitting or patching required to complete the Work or to make its parts fit together properly.

3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor

shall not cut or otherwise alter such construction by the Owner or a separate Contractor except with written consent of the Owner and of such separate Contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate Contractor the Contractor's consent to cutting or otherwise altering the Work.

3.15 Cleaning Up.

3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove from and about the Project site, all waste materials, rubbish, the Contractor's tools, construction equipment, machinery and surplus materials.

3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the cost thereof shall be charged to the Contractor.

3.16 Access to Work. The Contractor shall provide the Owner and Consultant access to the Work in preparation and progress wherever located.

3.17 Royalties and Payments. The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of patent rights and shall hold the Owner and Consultant harmless from loss on account thereof, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Contract Documents. However, if the Contractor has reason to believe that the required design, process or product is an infringement of a patent, the Contractor shall be responsible for such loss unless such information is promptly furnished to the Consultant.

3.18 Indemnification.

3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Consultant, Consultant's consultants, and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property other than the Work itself including loss of use resulting therefrom, but only to the extent caused in whole or in part by negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or person described in this Paragraph 3.18.

3.18.2 In claims against any person or entity indemnified under this Paragraph 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this Paragraph 3.18 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor under workmen's compensation acts.

ARTICLE 4: Administration of the Contract.

4.1 Owner's Representative (Consultant).

4.1.1 The Consultant is the person lawfully licensed to practice architecture or engineering or an entity lawfully practicing architecture or engineering identified as such in the Contract or a person who is employed by OCCC and designated as the Consultant, and is referred to throughout the Contract Documents as if singular in number. The term "Consultant" means the Consultant or the Consultant's authorized representative acting in the capacity as the Owner's Representative. The Consultant on a Project may be an employee of OCCC (may also be referred to as a Supervisory Official) or may be from the private sector.

4.1.2 Duties, responsibilities and limitations of authority of the Consultant as set forth in the Contract Documents shall not be restricted, modified or extended without written consent of the Owner and Consultant. Consent shall not be unreasonably withheld.

4.1.3 In case of termination of employment of the Consultant, the Owner shall appoint a Consultant against whom the Contractor makes no reasonable objection and whose status under the Contract Documents shall be that of the former Consultant.

4.2 Consultant's Administration of the Contract.

4.2.1 The Consultant will provide administration of the Contract as described in the Contract Documents, and will be the Owner's representative (1) during construction, (2) until final payment is due and (3) with the Owner's concurrence, from time to time during the correction period described in Paragraph 12.2. The Consultant will advise and consult with the Owner. The Consultant will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents, unless otherwise modified by written instrument in accordance with other provisions of the Contract.

4.2.2 The Consultant and sub-consultants will visit the site at intervals appropriate to the stage of construction to become generally familiar with the progress and quality of the completed Work and to determine in general if the Work is being performed in a manner indicating that the Work, when completed, will be in accordance with the Contract Documents. However, the Consultant will not be required to make exhaustive or continuous on-site inspections to check quality or quantity of the Work. Based on onsite observations, the Consultant will keep the Owner informed of progress of the Work, and will endeavor to guard the Owner against defects and deficiencies in the Work.

4.2.3 The Consultant will not have control over or charge of and will not be responsible for construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work, since these are solely the Contractor's responsibility as provided in Paragraph 3.3. The Consultant will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents. The Consultant will not have control over or charge of and will not be responsible for acts or omissions of the Contractor, Subcontractors, or their agents or employees, or of any other persons performing portions of the Work.

4.2.4 **Communications Facilitating Contract Administration.** Except as otherwise provided in the Contract Documents or when direct communications have been specially authorized, the Owner and Contractor shall endeavor to communicate through the Consultant. Communications by and with the Consultant's consultants shall be through the Consultant. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with separate contractors shall be through the Owner.

4.2.5 Based on the Consultant's observations and evaluations of the Contractor's Applications for Payment, the Consultant will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

4.2.6 The Consultant will have authority to reject Work that does not conform to the Contract Documents. Whenever the Consultant considers it necessary or advisable for implementation of the intent of the Contract Documents, the Consultant will have authority to require additional inspection or testing of the Work in accordance with Subparagraphs 13.5.2 and 13.5.3 whether or not such Work is fabricated, installed or completed. However, neither this authority of the Consultant nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Consultant to the Contractor, Subcontractors, material and equipment suppliers, their agents or employees, or other persons performing portions of the Work.

4.2.7 The Consultant will review and approve or take other appropriate action upon the Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Consultant's action will be taken with such reasonable promptness as to cause no delay in the Work or in the activities of the Owner, Contractor or separate Contractors, while allowing sufficient time in the Consultant's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Consultant's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Paragraphs 3.3, 3.5 and 3.12. The Consultant's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Consultant, of any construction means, methods, techniques, sequences or procedures. The Consultant's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

4.2.8 When modifications to the Contract or Contract Documents are being requested, the Contractor shall prepare and submit a Change Order to the Consultant. If approved by the Consultant, the "Change Order" shall be forwarded to the Owner for OCCC Board of Regents review and approval. The Work described in the approved Change Order may be started by the Contractor upon receipt of the approved "Change Order".

4.2.9 The Consultant will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion, will receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor, and will issue a final Certificate for Payment upon compliance with the requirements of the Contract Documents.

4.2.10 If the Owner and Consultant agree, the Consultant will provide one or more project representatives to assist in carrying out the Consultant's responsibilities at the site. The duties, responsibilities and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

4.2.11 The Consultant will interpret and decide matters concerning performance under and requirements of the Contract Documents on written request of either the Owner or Contractor. The Consultant's response to such requests will be made with reasonable promptness and within any agreed time limits. If no agreement is made concerning the time within which interpretations required of the Consultant shall be furnished in compliance with this Paragraph 4.2, then delay shall not be

recognized on account of failure by the Consultant to furnish such interpretations until 15 days after written request is made for them.

4.2.12 Interpretations and decisions of the Consultant will be consistent with the intent of and reasonably inferable from the Contract Documents and will be in writing or in the form of drawings.

4.3 **Claims and Disputes.**

4.3.1 **Definition.** A Claim is a demand or assertion by the Contractor seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. Claims must be made by submitting a Change Order.

4.3.2 **Decision of Consultant.** Claims, including those alleging an error or omission by the Consultant, shall be referred initially to the Consultant for action as provided in Paragraph 4.4. A decision by the Consultant, as provided in Subparagraph 4.4.4, shall be required as a condition precedent to consideration by the Owner.

4.3.3 **Time Limits on Claims.** Claims must be made within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later. Claims must be made by written notice. An additional Claim made after the initial Claim has been implemented by Change Order will not be considered unless submitted in a timely manner.

4.3.4 **Continuing Contract Performance.** Pending final resolution of a Claim, including protest, except as otherwise agreed in writing or with exception to 9.6.7, Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make monthly progress payments in accordance with the Contract Documents.

4.3.5 **Waiver of Claims: Final Payment.** The making of final payment shall constitute a waiver of Claims except those arising from:

- a. liens, Claims, security interests or encumbrances arising out of the Contract and unsettled;
- b. failure of the Work to comply with the requirements of the Contract Documents; or
- c. terms of special warranties required by the Contract Documents.

4.3.6 **Claims for Concealed or Unknown Conditions.** If conditions are encountered at the site which are (1) subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, then written notice by the Contractor shall be given to the Consultant and Owner promptly before conditions are disturbed and in no event later than seven (7) days after first observance of the conditions. The failure by the Contractor to give such written notice of the discovered concealed or unknown condition prior to executing any additional Work shall constitute a waiver of any claim for additional compensation or time extension. Upon receipt of a written notice, the Consultant will promptly investigate such conditions and, if they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend an equitable adjustment in the Contract Sum or Contract Time, or both. Any change in the Contract Sum or Contract Time shall only be made by the execution of a Change Order. If the Consultant determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Consultant shall so notify the Owner and Contractor in writing, stating the reasons. Claims by the Contractor in opposition to such determination must be made within 21 days after the Consultant has given notice of the decision.

4.3.7 **Claims for Additional Cost.** If the Contractor wishes to make Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Paragraph 10.3. If the Contractor believes additional cost is involved for reasons including but not limited to

- (1) a written interpretation from the Consultant,
- (2) an order by the Owner to stop the Work where the Contractor was not at fault,
- (3) a written order for a minor change in the Work issued by the Consultant,
- (4) failure of payment by the Owner,
- (5) termination of the Contract by the Owner,
- (6) Owner's suspension, or

(7) other reasonable grounds,

Claim shall be filed in accordance with the procedure established herein. Any change in the Contract Sum shall only be made by the execution of a Change Order.

4.3.8 Claims for Additional Time

a. If the Contractor wishes to make Claim for an increase in the Contract Time, written notice as provided herein shall be given. The Contractor's Claim shall include a description of the probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary. Any change in the Contract Time shall only be made by the execution of a Change Order.

b. The Contract construction time was determined by the estimated construction time with additional time added for project days lost due to typical adverse weather conditions in the project vicinity. Consideration was given to the projected starting date and an anticipated schedule of work. Adverse weather conditions include abnormal precipitation, temperature and wind conditions. Claims for additional time may be made when the actual weather conditions at the project site cause delay days that exceed the days indicated below.

Month/Work days lost included in Contract Time

Oklahoma City, OK

January 8	February 8	March 5	April 5	May 3	June 3	July 1	August 1
September 1	October 2	November 3	December 4				

Total 44

c. All claims for additional days that exceed the workdays lost as indicated above shall be submitted with documentation from a recognized climatological source such as the Oklahoma Climatological Survey (www.mesonet.ou) or the National Oceanic & Atmospheric Administration (NOAA) (www.noaa.gov). Other sources must be submitted to the Consultant and Owner for approval.

d. All claims for additional time due to adverse weather conditions that exceed the days indicated on the above table shall be submitted with the next monthly payment application.

e. Weather conditions and lost workdays shall be recorded daily by the Contractor and submitted to the Consultant with the monthly payment applications.

f. Unused lost weather days, as indicated in paragraph 4.3.8.2, included in the Contract time shall be used by the Owner to offset lost time for other approved delay claims.

4.3.9 Injury or Damage to Person or Property. If either party to the Contract suffers injury or damage to person or property because of an act or omission of the other party, of any of the other party's employees or agents, or of others for whose acts such party is legally liable, written notice of such injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after first observance. The notice shall provide sufficient detail to enable the other party to investigate the matter. If a Claim for additional cost or time related to this Claim is to be asserted, it shall be filed as provided in Subparagraphs 4.3.7 or 4.3.8.

4.4 Resolution of Claims and Suits.

4.4.1 The Consultant will review Claims and take one or more of the following preliminary actions within ten days of receipt of a Claim: (1) request additional supporting data from the claimant, (2) reject the Claim in whole or in part, stating reasons for rejection, (3) recommend approval of the Claim by the Owner or (4) suggest a compromise. The Consultant may also, but is not obligated to notify the surety, if any, of the nature and amount of the Claim.

4.4.2 If a Claim has been resolved, the Consultant will prepare or obtain appropriate documentation.

4.4.3 If a Claim has not been resolved, the Contractor shall, within ten days after the Consultant's preliminary response, take one or more of the following actions: (1) submit additional supporting data requested by the Consultant, (2) modify the initial Claim or (3) notify the Consultant that the initial Claim stands.

4.4.4 If a Claim has not been resolved after consideration of the foregoing and of further evidence presented to the Owner by the Consultant or Contractor, the Owner will notify the Consultant and Contractor in writing that the Owner's decision will be made within seven days. Upon expiration of such time period, the Owner will render to the parties the Owner's written decision relative to the Claim, including any change in the Contract Sum or Contract Time or both. If there is a surety and there

appears to be a possibility of a Contractor's default, the Owner may, but is not obligated to, notify, the surety and request the surety's assistance in resolving the controversy.

ARTICLE 5: Subcontractors.

5.1 Definitions.

5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a separate contractor or subcontractors of a separate contractor.

5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

5.2 Award of Subcontracts and other Contracts for Portions of the Work.

5.2.1 The Contractor, within seven (7) days, shall furnish in writing to the Owner, through the Consultant, the names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each principal portion of the Work. The Consultant will promptly reply to the Contractor in writing stating whether or not the Owner or the Consultant, after due investigation, has reasonable objection to any such proposed person or entity. Failure of the Owner or Consultant to reply promptly shall constitute notice of no reasonable objection.

5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Consultant has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

5.2.3 If the Owner or Consultant has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Consultant has no reasonable objection. The Contract Sum shall be increased or decreased by the difference in cost occasioned by such change and an appropriate Change Order shall be issued. However, no increase in the Contract Sum shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

5.2.4 The Contractor shall not change a Subcontractor, person or entity previously selected if the Owner or Consultant makes reasonable objection to such change.

5.3 **Sub Contractual Relations.** By appropriate agreement, written where legally required for validity, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these Documents, assumes toward the Owner and Consultant. Each subcontract agreement shall preserve and protect the rights of the Owner and Consultant under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement which may be at variance with the Contract Documents. Subcontractors shall similarly make copies of applicable portions of such documents available to their respective proposed Sub- subcontractors.

5.4 Contingent Assignment of Subcontracts.

5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner provided that:

- a. assignment is effective only after termination of the Contract by the Owner for cause pursuant to Paragraph 14.2 and only for those subcontract agreements which the Owner accepts by notifying the Subcontractor in writing; and
- b. assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

5.4.2 If the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted.

ARTICLE 6: Construction by Owner or by Separate Contractor(s).

6.1 **Owner's Right to Perform Construction and to Award Separate Contracts.**

6.1.1 The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site under Conditions of the Contract identical or substantially similar to these including those portions related to insurance and waiver of subrogation. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, the Contractor shall make such Claim as provided elsewhere in the Contract Documents.

6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner- Contractor Contract.

6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each separate contractor with the Work of the Contractor who shall cooperate with them. The Contractor shall participate with other separate contractors and the Owner in reviewing their construction schedules when directed to do so. The Contractor shall make any revisions to the construction schedule and Contract Sum deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, separate contractors and the Owner until subsequently revised.

6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces, the Owner shall be deemed to be subject to the same obligations and to have the same rights that apply to the Contractor under the Conditions of the Contract.

6.2 **Mutual Responsibility.**

6.2.1 The Contractor shall afford the Owner and separate contractors' reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a separate contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly report to the Consultant apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of the Contractor to so report shall constitute an acknowledgment that the Owner's or separate contractors completed or partially completed construction is fit and proper to receive the Contractor's Work, except as to defects not then reasonably discoverable.

6.2.3 Costs caused by delays or by improperly timed activities or defective construction shall be borne by the party responsible therefor.

6.2.4 The Contractor shall promptly remedy damage wrongfully caused by the Contractor to completed or partially completed construction or to property of the Owner or separate contractors as provided in Subparagraph 10.2.5.

6.2.5 Claims and other disputes and matters in question between the Contractor and a separate contractor shall be subject to the provisions of Paragraph 4.3 provided the separate contractor has reciprocal obligations.

6.2.6 The Owner and each separate contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Paragraph 3.14.

6.3 **Owner's Right to Clean Up.** If a dispute arises among the Contractor, separate contractors and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish as described in Paragraph 3.15, the Owner may clean up and allocate the cost among those responsible as the Consultant determines to be just.

ARTICLE 7: Changes in the Work.

7.1 **Changes.**

7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Section 7 and elsewhere in the Contract Documents.

7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor and Consultant; a Construction Change Directive requires agreement by the Owner and Consultant and may or may not be agreed to by the Contractor; an order for a minor change in the Work may be issued by the Consultant alone.

7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Change Order.

7.1.4 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are so changed in a proposed Change Order that application of such unit prices to quantities of Work proposed will cause substantial inequity to the Owner or Contractor, the applicable unit prices may be equitably adjusted by negotiation.

7.1.5 A Change Order shall be submitted by the Contractor and approved and executed by the Consultant, and Owner before any Work, including Work using unit prices, is started.

7.2 Change Orders.

7.2.1 A Change Order is a written instrument prepared by the Consultant and signed by the Owner, Contractor and Consultant, stating their agreement upon all of the following:

- a. a change in the Work;
- b. the amount of the adjustment in the Contract Sum, if any; and
- c. the extent of the adjustment in the Contract Time, if any.

7.2.2 The cost or credit to the Owner resulting from a change in the work shall be determined by the Contractor completing Change Order that requires a listing of:

- a. all materials with the cost per item;
- b. all labor with the number and cost of hours;
- c. all equipment used with an hourly cost;
- d. cost of insurance and bonds;
- e. cost of fringe benefits;
- f. overhead costs, which are limited to 15%; and
- g. profit which is limited to 10%.

7.2.3 The Contractor must include a breakdown of costs for each Subcontractor similar to the requirements in Paragraph 7.2.2.

7.2.4 In the case where direct costs are incurred by a Sub-contractor (or a Sub sub-contractor) fees for overhead and profit shall be limited to 15% and 10% respectively and an additional fee may be applied by the Contractor (and Sub-contractor in the case of a Sub sub-contractor) not to exceed 15% (includes both overhead and profit) of the increase in cost. Bond cost, insurance cost, social security taxes (FICA), workmen's compensation, employee fringe benefits and other taxes may be added by the contractors.

7.3 Construction Change Directives.

7.3.1 A Construction Change Directive is a written order prepared by the Consultant and signed by the Owner and Consultant, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- a. mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- b. unit prices stated in the Contract Documents or subsequently agreed upon;
- c. cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- d. as provided in Subparagraph 7.3.6.

7.3.4 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Consultant of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

7.3.5 A Construction Change Directive signed by the Contractor indicates the agreement of the Contractor therewith, including adjustment in the Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

7.3.6 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the method and the adjustment shall be determined by the Consultant on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, a reasonable allowable for overhead and profit. In such case, and also under Clause 7.3.3.3, the Contractor shall keep and present, in such form as the Consultant may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Subparagraph 7.3.6 shall be limited to the following:

- a. costs of labor, including social security and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
- b. costs of materials, supplies and equipment, including cost of transportation, whether incorporated or consumed;
- c. rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
- d. costs of premiums for all bonds and insurance, permit fees, and sales, use or similar taxes related to the Work; and
- e. additional costs of supervision and field office personnel directly attributable to the change.

7.3.7 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change which results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Consultant. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured based on net increase, if any, with respect to that change.

7.3.8 Pending final determination of the total cost of a Construction Change Directive to the Owner, amounts not in dispute for such changes in the Work shall be included in Applications for Payment accompanied by a Change Order indicating the parties' agreement with part or all of such costs. For any portion of such cost that remains in dispute, the Consultant will make an interim determination for purposes of monthly certification for payment for those costs. That determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a claim in accordance with Article 4.

7.3.9 When the Owner and Contractor agree with the determination made by the Consultant concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and shall be recorded by preparation and execution of an appropriate Change Order.

7.4 Minor Changes in the Work. The Consultant will have authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes shall be affected by written order and shall be binding on the Owner and Contractor. The Contractor shall carry out such written orders promptly.

ARTICLE 8: Time.

8.1 Definitions.

8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments by Change Order, allotted in the Contract Documents for Substantial Completion of the Work.

8.1.2 The date of commencement of the Work is the date established in the Notice to Proceed/WORK ORDER. The date shall not be postponed by the failure of acts of the Contractor or of persons or entities for whom the Contractor is responsible.

8.1.3 The date of Substantial Completion is the date certified by the Consultant and approved by the Owner in accordance with Paragraph 9.8.

8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

8.2 Progress and Completion.

8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Contract, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, prematurely commence operations on the site or elsewhere prior to the date of commencement as established by the WORK ORDER issued by the Owner.

8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

8.3 Delays and Extensions for Time.

8.3.1 If the Contractor is delayed at any time in progress of the Work by an act or neglect of the Owner or Consultant, or of an employee of either, or of a separate contractor employed by the Owner, or by changes ordered in the Work, or by labor disputes, fire, unusual delay in deliveries, unavoidable casualties or other causes beyond the Contractor's control, or by delay authorized by the Owner pending hearing results, or by other causes which the Consultant determines may justify delay, then the Contract Time shall be extended by Change Order for such reasonable time as the Consultant and Owner may determine.

8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Paragraph 4.3.

8.3.3 An extension of the Contract Time is the sole and exclusive remedy available to the Contractor, in the event of delays described in Paragraph 8.3. In no event, and under no circumstances, shall the Contract Sum be increased, nor shall the Contractor claim, recover or receive payment for any delay to the Project, whether or not such delayed event is in the critical path of the construction schedule.

ARTICLE 9: Payments and Completion.

9.1 **Contract Sum.** The Contract Sum is stated in the Contract and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents. The Contract Sum shall only be changed by a Change Order.

9.2 **Schedule of Values.** Before the first Application for Payment is submitted, the Contractor shall submit to the Consultant and Owner a schedule of values allocated to various portions of the Work, prepared in such form and supported by such data to substantiate its accuracy as the Consultant and Owner may require. Each value indicated on the Schedule of Values shall be the exact amount of each subcontract or portion of the Work it represents. This schedule, unless objected to by the Consultant or Owner, shall be used as a basis for reviewing the Contractor's Applications for Payment.

9.3 Applications for Payment (Contract's Invoice).

9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Consultant an itemized Application for Payment for operations completed in accordance with the schedule of values. Such application shall be notarized and supported by such data substantiating the Contractor's right to payment as the Owner or Consultant may require, such as copies of requisitions from Subcontractors and material suppliers.

a. Up to five percent (5%) of all partial payments made shall be withheld as retainage.

b. All payment applications must be on the Owner's form, "Contractor's Invoice".

Contractor's Invoice.

c. Such applications shall not include requests for payment of amounts the Contractor does not intend to pay to a Subcontractor or material supplier because of a dispute or other reason.

9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location properly bonded or insured as a warehouse for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include applicable insurance, storage and transportation to the site for such materials and equipment stored off the site. All stored materials shall be protected from weather conditions by properly secured methods. The Owner shall not pay for stored materials that are not properly protected.

9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information and belief, be free and clear of liens, claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work.

9.4 **Certificates for Payment.**

9.4.1 The Consultant will, within seven days after receipt of the Contractor's Application for Payment, either issue to the Owner a Certificate for Payment, with a copy to the Contractor, for such amount as the Consultant determines is properly due, or notify the Contractor and Owner in writing of the Consultant's reasons for withholding certification in whole or in part as provided in Subparagraph 9.5.1. The Owner shall have the right to review and approve the Certificates for Payment.

9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Consultant to the Owner, based on the Consultant's observations at the site and the data comprising the Application for Payment, that the Work has progressed to the point indicated and that, to the best of the Consultant's knowledge, information and belief, quality of the Work is in accordance with the Contract Documents.

9.5 **Decisions to Withhold Certification.**

9.5.1 The Consultant or Owner may decide not to certify payment and may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Consultant's opinion the representations to the Owner required by Subparagraph 9.4.2 cannot be made. If the Consultant is unable to certify payment in the amount of the Application, the Consultant will notify the Contractor and Owner as provided in Subparagraph 9.4.1. If the Contractor and Consultant cannot agree on a revised amount, the Consultant will promptly issue a Certificate for Payment for the amount for which the Consultant is able to make such representations to the Owner. The Consultant may also decide not to certify payment or, because of subsequently discovered evidence or subsequent observations, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Consultant's opinion to protect the Owner from loss because of:

- a. defective Work not remedied;
- b. third party claims filed or reasonable evidence indicating probable filing of such claims;
- c. failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment;
- d. reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- e. damage to the Owner or another Contractor;
- f. reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or
- g. persistent failure to carry out the Work in accordance with the Contract Documents.

9.5.2 When the above reasons for withholding certification are removed, certification will be made for amounts previously withheld.

9.6 **Progress Payments.**

9.6.1 After the Consultant has issued a Certificate for Payment, the Owner shall review for approval and make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Consultant.

9.6.2 The Contractor shall promptly pay each Subcontractor, upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of such Subcontractor's portion of the Work, the amount to which said Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of such Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in similar manner.

9.6.3 The Consultant will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Consultant and Owner on account of portions of the Work done by such Subcontractor.

9.6.4 Neither the Owner nor Consultant shall have an obligation to pay or to see to the payment of money to a Subcontractor except as may otherwise be required by law.

9.6.5 Payment to material suppliers shall be treated in a manner similar to that provided in Subparagraphs 9.6.2, 9.6.3 and 9.6.4.

9.6. A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

9.6.7 Progress payments shall be discontinued after the Contract Time, including approved Change Orders, has been exceeded. No additional progress payments will be made until Substantial Completion of the Work.

9.7 Failure of Payment.

9.7.1 If the Consultant does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within thirty days after the date of receipt from the Consultant, the Contractor may be entitled to interest on the certified amount.

9.7.2 Interest shall be paid to the Contractor at the prevailing state rate on the final payment if the payment is delayed more than thirty (30) days after the Contract is completed, accepted, and all required materials, certificates and other required documentation have been provided to the Owner.

9.8 Substantial Completion.

9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so the Owner can occupy or utilize the Work for its intended use.

9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Consultant a comprehensive list of items to be completed or corrected. The Contractor shall proceed promptly to complete and correct items on the list. Failure to include all items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. Upon receipt of the Contractor's list, the Consultant will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Consultant's inspection discloses any item, whether or not included on the Contractor's list, which is not in accordance with the requirements of the Contract Documents, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Consultant. The Contractor shall then submit a request for another inspection by the Consultant to determine Substantial Completion. When the Work or designated portion thereof is substantially complete, the Owner will prepare a Certificate of Substantial Completion which shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion. The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate.

9.8.3 Upon Substantial Completion of the Work or designated portion thereof and upon application by the Contractor and certification by the Consultant, the Owner shall make payment, reflecting adjustment in retainage, if any, for such Work or portion thereof as provided in the Contract Documents.

9.9 Partial Occupancy or Use.

9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is authorized by the Owner. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, Retainage if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Consultant as provided under Subparagraph 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Consultant.

9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor and Consultant shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

9.10 Final Completion and Final Payment.

9.10.1 Upon receipt of written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Consultant will promptly make such inspection and, when the Consultant finds the Work acceptable under the Contract Documents and the Contract fully performed, the Consultant will promptly issue a final Certificate for Payment stating that to the best of the Consultant's knowledge, information and belief, and on the basis of the Consultant's observations and inspections, the Work has been completed in accordance with terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor and noted in said final Certificate is due and

payable. The Consultant's final Certificate for Payment will constitute a further representation that conditions listed in Subparagraph 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Consultant an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied.

9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Consultant so confirms, the Owner shall, upon application by the Contractor and certification by the Consultant, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Consultant prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of claims. The making of final payment shall constitute a waiver of claims by the Owner as provided in Subparagraph 4.3.5.

9.10.4 Acceptance of final payment by the Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment. Such waivers shall be in addition to the waiver described in Subparagraph 4.3.5.

9.10.5 When the Contract Time has been exceeded, including approved Change Orders, and claims for additional compensation are submitted by Consultants for extended services and approved by the Owner, the Owner shall deduct the amount of the claims from the final payment to the Contractor.

ARTICLE 10: Protection of Persons and Property.

10.1 Safety Precautions and Programs.

10.1.1 The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract.

10.1.2 In the event the Contractor encounters on the site material reasonably believed to be asbestos or polychlorinated biphenyl (PCB) which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner and Consultant in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner and Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless, by written agreement of the Owner and Contractor.

10.1.3 The Contractor shall not be required (pursuant to Article 7) to perform any Work without consent relating to asbestos or polychlorinated biphenyl (PCB).

10.2 Safety of Persons and Property.

10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury or loss to:

- a. employees on the Work and other persons who may be affected thereby;
- b. the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody or control of the Contractor or the Contractor's Subcontractors or Sub-subcontractors; and
- c. other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

10.2.2 The Contractor shall give notices and comply with applicable laws, ordinances, rules, regulations and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury or loss.

10.2.3 The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent sites and utilities.

10.2.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Clauses 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Clauses 10.2.1.2 and 10.2.1.3, except damage or loss attributable to acts or omissions of the Owner or Consultant or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Paragraph 3.18.

10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Consultant.

10.2.7 The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.

10.3 **Emergencies.**

10.3.1 In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Paragraph 4.3 and Section 7.

ARTICLE 11: Insurance and Bonds.

11.1 **Contractor's Liability Insurance.**

11.1.1 The Contractor shall purchase from and maintain in a company or companies lawfully authorized to do business in the State of Oklahoma such insurance as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

- a. claims under workmen's compensation;
- b. claims involving contractual liability
- c. liability insurance
- d. builder's risk insurance

11.1.2 The insurance required by Subparagraph 11.1.1 shall be written for not less than limits of liability specified in the Contract Documents or required by law, whichever coverage is greater. Coverage, whether written on an occurrence or claims-made basis, shall be maintained without interruption from date of commencement of the Work until date of final payment and termination of any coverage required to be maintained after final payment.

11.1.3 Certificates of Insurance acceptable to the Owner shall be filed with the Owner with the executed Contract. These Certificates and the insurance policies required by this Paragraph 11.1 shall contain a provision that coverage afforded under the policies will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner.

11.2 **Performance Bond, Payment Bond and Defect Bond.**

11.2.1 The Contractor is required to have three bonds for Contracts exceeding One Hundred Thousand Dollars (\$100,000.00):

- a. Performance Bond for 100% of the value of the Contract to insure completion of the Work.
- b. Defect Bond for 100% of the value of the Contract to provide correction of defects in the construction and equipment for one year after acceptance of the Work; and
- c. Payment Bond for 100% of the Contract to assure that the Owner is protected from the action of Subcontractors, suppliers and employees for unpaid debts of the Contractor.

11.2.2 All bonds shall be on the forms prescribed and issued by the Owner. All bond submittals shall contain all terms and conditions of the bonds or applicable to the bonds.

11.2.3 Irrevocable Letters of Credit may be used as a substitute for the bonds required above. The Letters must be on the forms prescribed and provided by the Owner and issued by a financial institution insured by Federal Deposit Insurance Corporation or the Federal Savings and Loan Insurance Corporation.

11.2.4 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor or the Owner shall promptly furnish a copy of the bonds or of letters of credit or shall permit a copy to be made.

ARTICLE 12: Uncovering and Correction of Work.

12.1 Uncovering of Work.

12.1.1 If a portion of the Work is covered contrary to the Consultant's request or to requirements specifically expressed in the Contract Documents, it must, if required in writing by the Consultant, be uncovered for the Consultant's observation and be replaced at the Contractor's expense without change in the Contract Time.

12.1.2 If a portion of the Work has been covered which the Consultant has not specifically requested to observe prior to its being covered, the Consultant may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be charged to the Owner. If such Work is not in accordance with the Contract Documents, the Contractor shall pay such costs unless the condition was caused by the Owner or a separate contractor in which event the Owner shall be responsible for payment of such costs.

12.2 Correction of Work.

12.2.1 The Contractor shall promptly correct Work rejected by the Consultant or failing to conform to the requirements of the Contract Documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. The Contractor shall bear costs of correcting such rejected Work, including additional testing and inspections and compensation for the Consultant's services and expenses made necessary thereby.

12.2.2 If, within one year after the date of Substantial Completion of the Work or designated portion thereof, or after the date for commencement of warranties established herein, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of written notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. This period of one year shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual performance of the Work. This obligation under this Subparagraph 12.2.2 shall survive acceptance of the Work under the Contract and termination of the Contract. The Owner shall give such notice promptly after discovery of the condition.

12.2.3 The Contractor shall remove from the site portions of the Work which are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

12.2.4 If the Contractor fails to correct nonconforming Work within a reasonable time, the Owner may correct it in accordance with Paragraph 2.3. If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice from the Consultant, the Owner may remove it and store the salvable materials or equipment at the Contractor's expense. If the Contractor does not pay costs of such removal and storage within ten days after written notice, the Owner may upon ten additional days written notice sell such materials and equipment at auction or at private sale and shall account for the proceeds thereof, after deducting costs and damages that should have been borne by the Contractor, including compensation for the Consultant's services and expenses made necessary thereby. If such proceeds of sale do not cover costs which the Contractor should have borne, the Contract Sum shall be reduced by the deficiency. If payments then or thereafter due the Contractor are not sufficient to cover such amount, the Contractor shall pay the difference to the Owner.

12.2.5 The Contractor shall bear the cost of correcting destroyed or damaged construction, whether completed or partially completed, of the Owner or separate Contractors caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

12.2.6 Nothing contained in this Paragraph 12.2 shall be construed to establish a period of limitation with respect to other obligations that the Contractor might have under the Contract Documents. Establishment of the time period of one year as described in Subparagraph 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

12.3 Acceptance of Non-conforming Work.

12.3.1 If the Owner prefers to accept Work which is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be affected whether or not final payment has been made.

ARTICLE 13: Miscellaneous Provisions.

13.1 Governing Law.

13.1.1 The Contract shall be governed by the laws of the State of Oklahoma without reference to its conflict of law provisions and the obligations, rights and remedies of the parties hereunder shall be determined in accordance with such laws.

13.1.2 The parties submit to the exclusive jurisdiction of the District Courts of Oklahoma for Oklahoma County in any action or proceeding arising out of or relating to this Contract, with venue solely in Oklahoma City, Oklahoma.

13.2 Successors and Assigns.

13.2.1 The Contractor respectively binds itself, its partners, successors, assigns and legal representatives to the other party hereto and to partners, successors, assigns and legal representatives of such other party in respect to covenants, agreements and obligations contained in the Contract Documents. The Contractor shall not assign the Contract as a whole without written consent of the Owner. If the Contractor attempts to make such an assignment without such consent, the Contractor shall nevertheless remain legally responsible for all obligations under the Contract.

13.3 Written Notice.

13.3.1 Written notice shall be deemed to have been duly served if delivered in person to the individual or a member of the firm or entity or to an officer of the corporation for which it was intended, or if delivered at or sent by certified mail, return receipt requested, to the last business address known to the party giving notice.

13.4 Rights and Remedies.

13.4.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights and remedies otherwise imposed or available by law.

13.4.2 No action or failure to act by the Owner, Consultant or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed in writing.

13.5 Tests and Inspections.

13.5.1 Tests, inspections and approvals of portions of the Work required by the Contract Documents shall be made at appropriate times as specified. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with the independent testing laboratory under separate contract with the Owner. The Contractor shall give the Consultant timely notice of when and where tests and inspections are to be made so the Consultant may observe such procedures. The Owner shall bear costs of tests, inspections or approvals.

13.5.2 If the Consultant or Owner determine that portions of the Work require additional testing, inspection or approval not included under Subparagraph 13.5.1, the Consultant will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection or approval by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Consultant of when and where tests and inspections are to be made so the Consultant may observe such procedures. The Owner shall bear such costs except as provided in Subparagraph 13.5.3.

13.5.3 If such procedures for testing, inspection or approval under Subparagraphs 13.5.1 and 13.5.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, the Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for the Consultant's services and expenses.

13.5.4 Required certificates of testing, inspection or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Consultant.

13.5.5 If the Consultant is to observe tests, inspections or approvals required by the Contract Documents, the Consultant will do so promptly and, where practicable, at the normal place of testing.

13.5.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

13.6 Interest.

13.6.1 Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at such rate as specified in current law.

ARTICLE 14: Termination or Suspension of the Contract.

14.1 Termination by the Contractor.

14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 days through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons performing portions of the Work under contract with the Contractor, for any of the following reasons:

- a. issuance of an order of a court or other public authority having jurisdiction;
- b. an act of government, such as a declaration of national emergency, making material unavailable; or
- c. If repeated suspensions, delays or interruptions by the Owner as described in Paragraph 14.3 constitute, in the aggregate, more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

14.1.2 If one of the above reasons exists, the Contractor may, upon seven additional day's written notice to the Owner and Consultant, terminate the Contract and recover from the Owner payment for Work executed and for proven loss with respect to materials, equipment, tools, and construction equipment and machinery, including reasonable overhead, profit and damages.

14.1.3 If the Work is stopped for a period of 60 days through no act or fault of the Contractor or a Subcontractor or their agents or employees or any other persons performing portions of the Work under contract with the Contractor because the Owner has persistently failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days written notice to the Owner and the Consultant, terminate the Contract and recover from the Owner as provided in Subparagraph 14.1.2.

14.2 Termination by the Owner for Cause.

14.2.1 The Owner may terminate the Contract if the Contractor:

- a. persistently or repeatedly refuses or fails to supply enough properly skilled workers or proper materials;
- b. fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
- c. persistently disregards laws, ordinances, or rules, regulations or orders of a public authority having jurisdiction;
- d. repeatedly fails to comply with the terms and conditions of the Contract and Contract Documents; or
- e. otherwise is in substantial breach of a provision of the Contract Documents.

14.2.2 When any of the above reasons exist, the Owner may without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days written notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- a. take possession of the site and of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- b. accept assignment of subcontracts pursuant to Paragraph 5.4; and
- c. finish the Work by whatever reasonable method the Owner may deem expedient.

14.2.3 When the Owner terminates the Contract for one of the reasons stated in Subparagraph 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Consultant's services and expenses made necessary thereby, such excess shall be paid to the Contractor. If such costs exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Consultant, upon application, and this obligation for payment shall survive termination of the Contract.

14.3 Suspension by the Owner for Convenience.

14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work in whole or in part for such period of time as the Owner may determine.

14.3.2 An adjustment shall be made for increases in the cost of performance of the Contract, including profit on the increased cost of performance, caused by suspension, delay or interruption. No adjustment shall be made to the extent:

- a. that performance is, was or would have been so suspended, delayed or interrupted by another cause which the Contractor is responsible; or
- b. that an equitable adjustment is made or denied under another provision of this Contract.

14.3.3 Adjustments made in the cost of performance may have a mutually agreed fixed or percentage fee.

14.4 Termination by the Owner for Convenience.

14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

14.4.2 Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall:

- a. cease operations as directed by the Owner in the notice;
- b. take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- c. except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment for Work executed, costs incurred by reason of such termination, reasonable overhead expenses related to contract termination and reasonable profit on the Work not executed.

ARTICLE 15: Americans with Disabilities Act of 1990 (ADA) (42 U.S.C. 12101). As a public entity, OCCC may only contract with other entities that comply with the ADA. Contractors, by signing the bid documents and entering into a contract with OCCC, signify that they are aware of and comply with the requirements of the ADA. Failure to comply with the ADA may require cancellation of a contract.

END OF GENERAL CONDITIONS



OKLAHOMA CITY
COMMUNITY COLLEGE

Sample Standard Agreement Form

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion.

AGREEMENT made as of the _____ day of _____, 20_____.

BETWEEN THE OWNER:

Oklahoma City Community College
7777 S. May Ave.
Oklahoma City, OK 73159

PROJECT: Main Campus/Main Building Air Handler Replacement

Bid #2-SFB-23-005

AND THE CONTRACTOR:

(Company Name)

(City, State ZIP)

(Address)

(Email) (Telephone Number)

In consideration of the mutual covenants and obligations contained herein, Owner and Contractor agree as set forth herein.

ARTICLE 1: The Contract Documents.

1.1 The Contract Documents consist of this Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications and Addenda issued prior to execution of this Agreement, other documents listed in this Agreement and Modifications issued after execution of this Agreement; these form the Contract, and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral. An enumeration of the Contract Documents, other than Modifications, appears in Article 8.

ARTICLE 2: The Work of this Contract.

2.1 The Contractor shall fully execute the Work described in the Contract Documents, except to the extent specifically indicated in the Contract Documents to be the responsibility of others.

ARTICLE 3: Date of Commencement and Substantial Completion.

3.1 The date of commencement of the Work shall be the date of this Agreement unless a different date is stated below or provision is made for the date to be fixed in a notice to proceed issued by the Owner.

3.2 The Contract Time shall be measured from the date of Notice to Proceed/Work Order.

3.3 The Contractor shall achieve Substantial Completion of the entire Work not later than [Days in Words] () calendar days from the date of commencement, or as follows: None, subject to adjustments of this Contract Time as provided in the Contract Documents.

ARTICLE 4: Contract Sum.

4.1 The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor's performance of the Contract. The Contract Sum shall be [Insert Amount in Words] Dollars (), subject to additions and deductions as provided in the Contract Documents.

4.2 The Contract Sum is based upon the following alternates, if any, which are described in the Contract Documents and are hereby accepted by the Owner.

None

4.3 Options. The following options shall remain available for 30 days after the contract date. After the expiration date, the cost of the option may be negotiated by the Owner and Contractor.

None

4.4 Unit prices, if any, are as follows:

None

ARTICLE 5: Payments.

5.1 Progress Payments.

5.1.1 Based upon Applications for Payment submitted to the Consultant by the Contractor and Certificates for Payment issued by the Consultant, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

5.1.3 The period covered by each Application for Payment shall be one calendar month ending on the last day of the month or as follows:

—

5.1.4 Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work. The schedule of values shall be prepared in such form and supported by such data to substantiate its accuracy as the Consultant may require. This schedule, unless objected to by the Consultant, shall be used as a basis for reviewing the Contractor's Application for Payment.

5.1.5 Applications for Payment shall indicate the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.

5.1.6 Subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

a. Take that portion of the Contract Sum properly allocable to completed Work as determined by multiplying the percentage completion of each portion of the Work by the share of the Contract Sum allocated to that portion of the Work in the schedules of values, less retainage of five percent (5%). Pending final determination of cost to the Owner of changes in the Work, amounts not in dispute shall be included as provided in Subparagraph 7.3.8 of General Conditions of the Contract for Construction ("General Conditions");

b. Add that portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction (or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing), less retainage of five percent (5%).

c. Subtract the aggregate of previous payments made by the Owner; and

d. Subtract amounts, if any, for which the Consultant has withheld or nullified a Certificate for Payment as provided in Subparagraph 9.5 of the General Conditions.

5.1.7 The progress payment amount determined in accordance with Subparagraph 5.1.6 shall be further modified under the following circumstances:

a. Add, upon Substantial Completion of the Work, a sum sufficient to increase the total payments to the full amount of the Contract Sum, less such amounts as the Consultant and Owner shall determine for incomplete Work, retainage applicable to such work and unsettled claims; and (state other requirements if any).

b. Add, if final completion of the Work is thereafter materially delayed through no fault of the Contractor, any additional amounts payable in accordance with Subparagraph 9.10.3 of the General Conditions.

5.1.8 Reduction or limitation of retainage, if any, shall be as follows: Refer to General Conditions, Subparagraph 9.3.1.a.

5.2 Final Payment.

5.2.1 Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when:

a. the Contractor has fully performed the Contract except for the Contractor's responsibility to correct Work as provided in Subparagraph 12.2.2 of the General Conditions, and to satisfy other requirements, if any, which extend beyond final payment; and

b. a final Certificate for Payment has been issued by the Consultant and accepted by the Owner.

5.2.2 The Owner's final payment to the Contractor shall be made no later than 30 days after the issuance of the Consultant's final Certificate for Payment.

ARTICLE 6: Termination or Suspension.

6.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of the General Conditions.

6.2 The Work may be suspended by the Owner as provided in Article 14 of the General Conditions.

ARTICLE 7: Miscellaneous Provisions.

7.1 Where reference is made in this Agreement to a provision of the General Conditions or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Document.

7.2 Payments due and unpaid under the Contract shall bear interest from the date payment is due at the legal state rate.

7.3 The Owner is Oklahoma City Community College; contact Chris Snow, Executive Director of Facilities Management.

7.4 The Owner's Representative (Consultant): [Insert Company Name and POC Name]

7.5 The Contractor's Representative is: [Insert Name].

7.6 Neither the Owner's nor the Contractor's representative shall be changed without ten days written notice to the other party.

7.7 Audits and Records Clause: As used in this clause, "records" includes books, documents, accounting procedures and practices, and other data, regardless of type and regardless of whether such items are in written form, in the form of computer data, or in any other form. In accepting any contract with Oklahoma City Community College, the Contractor agrees any pertinent State or Federal agency will have the right to examine and audit all records relevant to execution of the resultant contract. The contractor is required to retain all records relative to this contract for the duration of the contract term and for a

period of three years following completion and/or termination of the contract. If an audit, litigation, or other actions involving such records are started before the end of the three-year period, the records are required to be maintained for three years from the date that all issues arising out of the action are resolved or until the end of the three year retention period, whichever is later.

7.8 Oklahoma Taxpayer and Citizen Protection Act of 2007. The Contractor certifies that it and all proposed subcontractors and suppliers, whether known or unknown at the time this contract is executed or awarded, will comply with the provisions of the Oklahoma Taxpayer and Citizen Protection Act of 2007 and participate in the Status Verification System. The Status Verification System is defined in the Oklahoma Statutes, Title 25, section 1312.

7.9 State of Oklahoma Governor's Executive Order 2012-01. Per the State of Oklahoma Governor's Executive Order 201201, filed February 6, 2012 and effective July 1, 2012, the use of any tobacco product shall be prohibited on any and all properties owned, leased or contracted for use by the State of Oklahoma, including but not limited to all buildings, land and vehicles owned, leased or contracted for use by agencies or instrumentalities of the State of Oklahoma.

ARTICLE 8: Enumeration of Contract Documents.

8.1 The Contract Documents, except for Modifications issued after execution of this Agreement, are enumerated as follows:

8.1.1 The Agreement is this executed edition of the Standard Agreement Form between Owner and Contractor.

8.1.2 The General Conditions are the current edition of the General Conditions of the Contract for Construction, as incorporated in the Project Manual.

8.1.3 The Supplementary and other Conditions of the Contract are those contained in the Project Manual dated [Insert Project Manual Date] and are as follows:

<u>Document</u>	<u>Date</u>
-----------------	-------------

8.1.4 The Specifications are those contained in the Project Manual dated [Insert Specifications Date] as in Subparagraph 8.1.3, and are as follows:

<u>Number</u>	<u>Title</u>	<u>Date</u>
---------------	--------------	-------------

8.1.5 The Drawings are as follows, and are dated [Insert Drawings Date] unless a different date is shown below: Number
Title Date

8.1.6 The Addenda, if any, are as follows:

<u>Number</u>	<u>Date</u>	<u>Pages</u>
---------------	-------------	--------------

8.1.7 Portions of Addenda relating to bidding requirements are not part of the Contract Documents unless the bidding requirements are also enumerated in this Article 8.

8.1.8 Other documents, if any, forming part of the Contract Documents are as follows:

- Contract Provisions for Non-Federal Entity Contracts Under Federal Awards

Purchase Order
Notice to Proceed/Work Order [Enter Additional or DELETE]

This agreement is entered into as of the day and year first written above and is executed in at least four original copies, of which one is to be delivered to the Contractor, one to the Owner's Representative for use in the administration of the Contract, and the remainder to the Owner.

OWNER:

(Owner Signature)

(Date Signed)

(Title)

**CONTRACTOR:
Non-Collusion Statement**

The Authorized Representative for the Contractor, of lawful age, solemnly swears or affirms, under penalty of perjury, that (s)he is the duly authorized agent of the Company indicated herein under the contract which is attached to this statement, for the purpose of certifying the facts pertaining to the giving of things of value to government personnel in order to procure said Contract.

(S)He is fully aware of the facts and circumstances surrounding the making of the Contract to which this statement is attached and has been personally and directly involved in the proceedings leading to the procurement of said Contract: and

Neither the Company nor anyone subject to the Company's direction or control has paid, given or donated or agreed to pay, give or donate to any officer or employee of the State of Oklahoma any money or other thing of value, either directly or indirectly, in procuring the Contract to which this statement is attached.

(Authorized Representative Signature)

(Date Signed)

(Authorized Representative Printed Name)

(Authorized Representative Printed Title)

(EIN/TIN number)

Exhibits/Attachments list:



Oklahoma City Community College ■ Purchasing Department ■ John Massey Center ■ 7777 South May Avenue ■ Oklahoma City, OK 73159

PAYMENT BOND

Main Campus/Main Building Air Handler Replacement - Project #2-SFB-23-005

Project Name and Number

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable. This document may not be altered or modified.

OWNER (Obligee):
OKLAHOMA CITY COMMUNITY COLLEGE
PURCHASING DEPARTMENT 405-682-7556
7777 South May Avenue
OKLAHOMA CITY, OK 73159

michael.c.sisco@occc.edu

73159

PROJECT:
#2-SFB-23-005
(Project Number)

Main Campus/Main Building Air Handler Replacement
(Project Name)

7777 South May Avenue, Oklahoma City, OK
(Address/Location)

PRINCIPAL (Contractor):

(Company Name)

(Address)

(City, State, Zip)

(Email address)

SURETY:

(Company Name)

(Address)

(City, State, Zip)

(Email address)

STANDARD AGREEMENT:

(Dated)

(Amount)

BOND DATE:

(Not earlier than date of Standard Agreement)

BOND AMOUNT (whole numbers only):

\$ _____
(Million) (Thousand) (Hundred) (cent)

(Bond Number)

DATED this ____ day of __, 20 ____

PRINCIPAL:

1. _____ 2. _____ 3. _____

(Authorized Representative Signature)

(Authorized Representative Signature)

(Authorized Representative Signature)

(Authorized Representative Printed Name)

(Authorized Representative Printed Name)

(Authorized Representative Printed Name)

(Authorized Representative Printed Title)

(Authorized Representative Printed Title)

(Authorized Representative Printed Title)

SURETY:

ATTEST:

(Surety Company Name)

(Notary Printed Name)

(Attorney-in-Fact Signature)

(Surety Seal)

(Notary Signature)

(Attorney-in-Fact Printed Name)

(Surety Telephone No.)
Seal)

(Notary

(Attach Power of Attorney)

FOR INFORMATIONAL PURPOSES ONLY

AGENT/BROKER:

OWNER REPRESENTATIVE (Consultant or Other Party):

(Company Name)

(Company Name)

(Address)

(Address)

(City, State, Zip)

(City, State, Zip)

(Email Address)

(Email Address)

1 The Contractor and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner to pay for labor, materials and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference.

2 With respect to the Owner, this obligation shall be null and void if the Contractor:

2.1 Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2 Defends, indemnifies and holds harmless the Owner from claims, demands, liens or suits by any person or entity whose claim, demand, lien or suit is for the payment for labor, materials or equipment furnished for use in the performance of the Construction Contract, provided the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 12) of any claims, demands, liens or suits to the Contractor and the Surety, and provided there is no Owner Default.

3 With respect to Claimants, this obligation shall be null and void if the Contractor promptly makes payment, directly or indirectly, for all sums due.

4 The Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with the Contractor have given notice to the Surety (at the

address described in Paragraph 12) and sent a copy, or notice thereof, to the Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with the Contractor:

4.2.1. Have furnished written notice to the Contractor and sent a copy, or notice thereof, to the Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials were furnished or supplied or for whom the labor was done or performed; and

4.2.2. Have either received a rejection in whole or in part from the Contractor, or not received within 30 days of furnishing the above notice any communication from the Contractor by which the Contractor has indicated the claim will be paid directly or indirectly; and

4.2.3. Not having been paid within the above 30 days, have sent a written notice to the Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to the Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the Contractor.

5 If a notice required by Paragraph 4 is given by the Owner to the Contractor or to the Surety, that is sufficient compliance.

6 When the Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at the Surety's expense take the following actions:

6.1 Send an answer to the Claimant, with a copy to the Owner, within 45 days after receipt of the claim, stating the amount that are undisputed and the basis for challenging any amounts that are disputed.

6.2 Pay or arrange for payment of any undisputed amounts.

7 The Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by the Surety. Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any Construction Performance Bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and the Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

8 The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.

9 No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Subparagraph 4.1 or Clause 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10 Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the signature page. Actual receipt of notice by Surety, the Owner or the Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

11 When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12 Upon request by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

13 DEFINITIONS

14.1. Claimant: An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

14.2. Construction Contract: The agreement between the Owner and the Contractor identified on the signature page, including all Contract Documents and changes thereto.

14.3. Owner Default: Failure of the Owner, which has neither been remedied nor waived, to pay the Contractor as required by the Construction Contract.



PERFORMANCE BOND

Main Campus/Main Building Air Handler Replacement - Project #2-SFB-23-005

Project Name and Number

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable. This document may not be altered or modified.

OWNER (Obligee):
OKLAHOMA CITY COMMUNITY COLLEGE
PURCHASING DEPARTMENT 405-682-7556
7777 South May Avenue
OKLAHOMA CITY, OK 73159
michael.c.sisco@occc.edu

PROJECT:
#2-SFB-23-005
(Project Number)

Main Campus/Main Building Air Handler Replacement
(Project Name)

7777 South May Avenue, Oklahoma City, OK 73159
(Address/Location)

PRINCIPAL (Contractor):

SURETY:

(Company Name)

(Company Name)

(Address)

(Address)

(City, State, Zip)

(City, State, Zip)

(Email address)

(Email address)

STANDARD AGREEMENT:

BOND DATE:

(Dated)

(Not earlier than date of Standard Agreement)

(Amount)

BOND AMOUNT (whole numbers only):

\$ _____, _____, _____, _____
(Million) (Thousand) (Hundred) (cent)

(Bond Number)

DATED this _____ day of _____, 20____

PRINCIPAL:

1. _____
(Authorized Representative Signature)

2. _____
(Authorized Representative Signature)

3. _____
(Authorized Representative Signature)

(Authorized Representative Printed Name)

(Authorized Representative Printed Name)

(Authorized Representative Printed Name)

(Authorized Representative Printed Title)

(Authorized Representative Printed Title)

(Authorized Representative Printed Title)

SURETY:

ATTEST:

(Surety Company Name)

(Notary Printed Name)

(Attorney-in-Fact Signature)

(Surety Seal)

(Notary Signature)

(Attorney-in-Fact Printed Name)

(Surety Telephone No.)
Seal)

(Notary

(Attach Power of Attorney)

FOR INFORMATIONAL PURPOSES ONLY

AGENT/BROKER:

OWNER REPRESENTATIVE (Consultant or

Other Party):

(Company Name)

(Company Name)

(Address)

(Address)

(City, State, Zip)

(City, State, Zip)

(Email Address)

(Email Address)

1. The Contractor and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except to participate in conferences as provided in Subparagraph 3.1.
3. The Surety's obligation under this Bond shall arise after:
 - 3.1 The Owner has notified the Contractor and the Surety at its address described in Paragraph 10 below that the Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with the Contractor and the Surety to be held not later than ten (10) days after receipt of such notice to discuss methods of performing the Construction Contract. If the Owner, the Contractor and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor's Default; and
 - 3.2 The Owner has declared a Contractor Default and formally terminated the Contractor's right to complete the contract. Such Contractor Default shall not be declared earlier than seven (7) days after the Contractor and the Surety have received notices as provided in Subparagraph 3.1; and
 - 3.3 The Owner has agreed to pay the Balance of the Contract Price to the Surety in accordance with the terms of the

Construction Contract or to a contractor selected to perform the Construction Contract in accordance with the terms of the contract with the Owner.

4. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions.

4.1 Arrange for a Contractor, with consent of the Owner, to perform and complete the Construction Contract; or

4.2 Undertake to perform and complete the Construction Contract itself, through its agents or through independent contractors; or

4.3 Obtain proposals or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and the contractor selected with the Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by the Owner resulting from the Contractor's default; or

4.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

4.4.1 After investigation, determine the amount for which it may be liable to the Owner, and as soon as practicable after the amount is determined, tender payment therefor to the Owner; or

4.4.2 Deny liability in whole or in part and notify the Owner citing reasons therefor.

5. If the Surety does not proceed as provided in Paragraph 4 with reasonable promptness, the Surety shall be deemed to be in default on this Bond fourteen (14) days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Subparagraph 4.4, and the Owner refuses the payment tendered or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

6. After the Owner has terminated the Contractor's right to complete the Construction Contract, and if the Surety elects to act under Subparagraph 4.1, 4.2, or 4.3 above, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. To the limit of the amount of this Bond, but subject to commitment by the Owner of the Balance of the Contract Price to mitigation of costs and damages on the Construction Contract, the Surety is obligated without duplication for:

6.1 The responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

6.2 Additional legal, design professional and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 4; and

6.3 Liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

7. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.

8. Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the signature page.

9. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provisions in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

10. DEFINITIONS

10.1 Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made, including allowance to the Contractor of any amounts received or to be received by the Owner in Settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

10.2 Construction Contract: The agreement between the Owner and the Contractor identified on the signature page, including all Contract Documents and changes thereto.

10.3 Contractor Default: Failure of the Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Construction Contract.

10.4 Owner Default: Failure of the Owner, which has neither been remedied nor waived, to pay the Contractor as required by the Construction Contract.



Oklahoma City Community College ■ Purchasing Department ■ John Massey Center ■ 7777 South May Avenue ■ Oklahoma City, OK 73159

Statutory Defect Bond

Main Campus/Main Building Air Handler Replacement - Project #2-SFB-23-005

Project Name and Number

61 O.S. §113 (B)(3)

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable. This document may not be altered or modified.

KNOW ALL MEN BY THESE PRESENTS:

That _____, as Principal and

a corporation organized under the laws of the State of _____ and authorized to transact business in the State of Oklahoma, as Surety, are held and firmly bound unto the State of Oklahoma in the penal sum of

_____ Dollars

(\$ _____)

in lawful money of the United States of America, said sum being equal to One Hundred Percent (100%) of the Contract

price, for the payment of which, well and truly to be made, we bind ourselves and each of us, our heirs, executors, administrators, trustees, successors, and assigns, jointly and severally, firmly by these presents:

The condition of this obligation is such that

WHEREAS, said Principal entered into a written contract with OCCC, dated _____, for

Project # _____
Number _____

all in compliance with the plans and specification, therefore made a part of said contract

and on file in the Purchasing Department at Oklahoma City Community College, 7777 South May Avenue, Oklahoma City, OK 73159

NOW, THEREFORE, if said Principal shall pay or cause to be paid to Oklahoma City Community College all damage, loss, and expense which may result by reason of defective materials and/or workmanship in connection with said work, occurring within a period of one (1) year from and after the acceptance of said project by Oklahoma City Community College; then this obligation shall be null and void, otherwise to be and remain in full force and effect.

It is expressly agreed and understood by the parties hereto that no changes or alterations in said Contract and no deviation from the plan or mode of procedure herein fixed shall have the effect of releasing the sureties, or any of them, from the obligations of this Bond.

IN WITNESS WHEREOF, the said Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and the said Surety has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact, duly authorized so to do, the day and year set forth below.

Dated this _____ day of _____, 20____

PRINCIPAL:

(Authorized Representative Signature)

BY:

(Authorized Representative Printed Name)

ATTEST:

SURETY:

(Notarial Seal & Signature)

(Attorney-in-Fact Signature)

BY: _____

(Authorized Representative Printed Name)



Oklahoma City Community College ■ Purchasing Department ■ John Massey Center ■ 7777 South May Avenue ■ Oklahoma City, OK 73159

Irrevocable Standby Letter of Credit

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion.

NUMBER _____, ISSUED in _____, Oklahoma on the _____ day of _____ in the year 20_____.

BENEFICIARY (Owner):

OKLAHOMA CITY COMMUNITY COLLEGE
 PURCHASING DEPARTMENT, 405-682-7556
 7777 South May Avenue
 Oklahoma City, OK 73159

michael.c.sisco@occc.edu

PROJECT:

#2-SFB-23-005
 (Project Number)

Main Campus/Main Building Air Handler
 Replacement
 (Project Name)

 (Address/Location)

APPLICANT (Bidder, Contractor, Constuction Manager, Design-Builder):

_____ (Company Name)	_____ (City, State, ZIP)	
_____ (Address)	_____ (Email)	_____ (Telephone Number)
ISSUING BANK		
_____ (Company Name)	_____ (City, State, ZIP)	
_____ (Address)	_____ (Email)	_____ (Telephone Number)

DATE AND PLACE OF EXPIRATION

- Pursuant to 61 O.S., Section 113, this Letter of Credit (of "X" appears in checkbox) shall remain in effect for a period of one (1) year after acceptance of the project, to protect the Beneficiary against deceptive workmanship and materials.

_____ (Time)	_____ (Date)	_____ (Place)
_____ (Time)	_____ (Date)	_____ (Place)
_____ (Time)	_____ (Date)	_____ (Place)
_____ (Time)	_____ (Date)	_____ (Place)

Issuing bank hereby establishes an irrevocable standby letter of credit at the request of the Applicant in favor of the Owner, and authorizes same to draw on us by sight draft, up to the aggregate amount of _____ US Dollars, (_____).

We further agree that:

1. This Letter of Credit shall be automatically extended without amendment for additional one-year periods from and after the above- referenced date of expiry, unless Issuing Bank has notified the Beneficiary, in writing, not less than 60 days before such date that Issuing Bank elects not to renew this Letter of Credit. The notice of Issuing Bank's election not to renew shall be sent to Beneficiary by registered mail to the above address, ATTN: Vice President for Administrative Services, Oklahoma City Community College

2. Upon receipt of Issuing Bank's notice not to renew, the Beneficiary may elect either to obtain cash collateral by drawing on a sight draft on the Issuing Bank for an amount not to exceed the unused balance of this Letter of Credit, or to let the Letter of Credit expire.

3. *(The clause selected with an "X" shall be the valid 3 clause)*

The purpose of this Letter of Credit is to fill the requirement of 61 O.S. Section 107. Drafts drawn by the Beneficiary under this Letter of Credit shall be accompanied by a written statement purportedly signed by the Vice President for Administrative Services certifying that "The Successful Bidder has failed to execute the contract or failed to provide the required bonds, or irrevocable letters of credit and insurance to the awarding public agency within the period of time, not to exceed sixty (60) days, specified in the bid notice by the awarding public agency." Except that drafts drawn in response to Issuing Bank's notice not to extend this Letter of Credit will not be accompanied by such statement from the Vice President for Administrative Services.

The purpose of this Letter of Credit is to fill the requirement of 61 O.S. Section 1 and 61 O.S. Section 113. Drafts drawn by the Beneficiary under this Letter of Credit shall be accompanied by an original copy of the Letter of Credit and a written statement purportedly signed by the Vice President for Administrative Services certifying to one or more of the following:

- a. "Contractor has failed to perform in accordance with the terms and conditions of Project Number _____ by and between Beneficiary and Contractor"; and/or,
- b. "Contractor has failed to pay all indebtedness incurred for the contractor's subcontractors and all suppliers of labor, material, rental of machinery or equipment, and or repair of and or parts for equipment the contract requires the contractor to furnish in accordance with the terms and conditions of Project Number _____ by and between Beneficiary and Contractor"; and/or
- c. "Contractor has performed defective workmanship and/or supplied defective materials in violation of the terms and conditions of Project Number _____ by and between Beneficiary and Contractor."

Except that drafts drawn in response to Issuing Bank's notice not to extend this Letter of Credit will not be accompanied by such statement from the Vice President for Administrative Services.

4. Issuing Bank hereby represents and affirms that the execution and tendering of this Letter of Credit has been duly authorized and will not constitute a violation of any applicable law, regulation, charter; or corporate restriction of Issuing Bank. Issuing Bank further represents and warrants that it is a financial institution insured by the Federal Deposit Insurance Corporation.

5. Unless automatically extended in accordance with paragraph 1 above, this Letter of Credit expires at 5:00 p.m. on the stated expiration date.

6. Draft(s) drawn and negotiated under this Letter of Credit shall state that it is "DRAWN UNDER ISSUING BANK LETTER OF CREDIT NUMBER _____ DATED _____, 20____."

7. Except as otherwise expressly stated herein, this Letter of Credit shall be governed by and construed in accordance with the laws of the State of Oklahoma and is subject to the Uniform Customs and Practices for Documentary Credits, International Chamber of Commerce Brochure No. 500 (UCP) in effect on the date of issuance of this Letter of Credit. In the event of any conflict between Oklahoma law and the UCP, Oklahoma law shall prevail. Venue for any action necessary to interpret or enforce this Letter of Credit shall lie in Oklahoma County, Oklahoma.

8. Reference to any contract is for information purposes only and is not part of this Letter of Credit.

We hereby engage with you that any draft drawn upon and in compliance with the terms of this credit will be duly honored on presentation at our office in, on or before 5:00 p.m. on the stated expiration date or any extended date as hereinabove provided.

ISSUING BANK:

<i>(Authorized Representative Signature)</i>	<i>(Date Signed)</i>	<i>(Authorized Representative Signature)</i>	<i>(Date Signed)</i>
<i>(Authorized Representative Printed Name)</i>		<i>(Authorized Representative Printed Name)</i>	
<i>(Authorized Representative Printed Title)</i>		<i>(Authorized Representative Printed Title)</i>	
<i>(Authorized Representative Signature)</i>	<i>(Date Signed)</i>	<i>(Authorized Representative Signature)</i>	<i>(Date Signed)</i>
<i>(Authorized Representative Printed Name)</i>		<i>(Authorized Representative Printed Name)</i>	
<i>(Authorized Representative Printed Title)</i>		<i>(Authorized Representative Printed Title)</i>	



CERTIFICATE OF COMPLIANCE

IMPORTANT: THIS MUST BE READ, SIGNED AND RETURNED WITH BID DOCUMENTS

Certificate of Compliance with Executive Order 11246 as amended for Contract in Excess of \$10,000.

In entering into any resulting contracts over \$10,000, the contractor agrees to comply with the Equal Employment Opportunity requirements stipulated in Executive Order 11246 as amended by Executive Order 11375. These specific requirements state:

- I. "Equal Opportunity Clause"
During the performance of this/these contract(s) the contractor agrees as follows:
 - A. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following:
Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.
 - B. The contractor will, in all solicitations or advancements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.
 - C. The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.
 - D. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the contractor's commitments under Section 202 of Executive Order No. 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
 - E. The contractor will comply will all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations and relevant orders of the Secretary of Labor.
 - F. The contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and order of the Secretary of Labor, or pursuant

thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations and orders.

- G. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations or orders, this contract may be cancelled, terminated or suspended in whole or part and the contractor may be declared ineligible for further government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965 and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.
- H. The contractor will include the provisions of paragraphs (A) through (H) in every subcontract or purchase order unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

II. Certification on Non-Segregated Facilities

By the submission of this bid and/or acceptance of purchase orders during the above period, the bidder, offeror, applicant, or subcontractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any locations under his control where segregated facilities are maintained. He further agrees that breach of this certification is a violation of the equal opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms, and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees, that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, sexual orientation, gender identity, or national origin because of written or oral policies or employee custom. He further agrees that (except where he has obtained identical certifications from proposed contractors for specific time periods) he will obtain identical certification from proposed subcontractors prior to award of subcontracts exceeding \$10,000 which are not tax exempt from the provision of the equal opportunity clause; that he will retain such certifications in his files; and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods).

III. Disabled Veteran and Vietnam Era Veteran Affirmative Action Program Requirements

In entering into any contract that exceeds \$10,000, the bidder agrees to comply with the Disabled Veteran and Vietnam Era Veteran Affirmative Action Program Requirements as stipulated in Public Law 93-508 and all amendments thereto. Failure to comply with the requirements of Public Law 93-508, Title 41, CFR60-250 and Title 41, CFR60-741 and all amendments thereto shall be deemed a material breach of this agreement and subject this contract to cancellation and rescission at the option of Oklahoma City Community College.

Certification of Compliance

If awarded this Contract _____ agrees to comply with the provisions of Clauses I, II, and III above.

Signature

Date

Printed Name

Title

STATE OF _____)

COUNTY OF _____)

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

Notary Public (or Clerk or Judge) Signature _____

My Commission Number _____

My Commission Expires _____

(Seal)



Oklahoma City Community College ■ Purchasing Department ■ John Massey Center ■ 7777 South May Avenue ■ Oklahoma City, OK 73159

NO BID RESPONSE FORM

Project # 2-SFB-23-005

Please be advised that our company does not wish to submit a proposal in response to the attached referenced Request for Proposal for the following reasons:

- _____ Too busy at this time
- _____ Not engaged in this type of work
- _____ Project too large/small
- _____ Cannot meet mandatory specifications (Please specify below)
- _____ Other (Please specify)

Company Name

Date

Signature

Title

Printed Name

Address

Phone Number

Email

Please return to:
Mr. Craig Sisco, Director of Purchasing
Oklahoma City Community College
Purchasing Office, JMC Room 140
Oklahoma City, Oklahoma 73159
michael.c.sisco@occc.edu

EXHIBITS

- Exhibit A – Detailed Electrical Specifications
- Exhibit B – Detailed Mechanical Specifications
- Exhibit C – Academic Calendar 2021-2022
- Exhibit D – Academic Calendar 2022-2023
- Exhibit E – SPECS 2022-05-16 (COMBINED DELIVERABLE)
- Exhibit F – Contract Provisions for Non-Federal Entity Contracts Under Federal Awards

EXHIBIT A

ELECTRICAL SYMBOLS					
LIGHTING AND POWER					
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	SURFACE MOUNTED CEILING LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		SURFACE MOUNTED WALL LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		CEILING MOUNTED EXIT LIGHT WITH DIRECTIONAL ARROW. SHADING INDICATES FACE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)
	RECESSED MOUNTED CEILING LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		RECESSED MOUNTED WALL LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		WALL OR END MOUNTED EXIT LIGHT WITH DIRECTIONAL ARROW. SHADING INDICATES FACE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)
	PENDANT MOUNTED CEILING LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		LIGHTING TRACK (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		COMBINATION CEILING MOUNTED EXIT/EMERGENCY BATTERY LIGHT WITH DIRECTIONAL ARROW. SHADING INDICATES FACE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)
	IN GRADE/FLOOR LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		TRACK MOUNTED LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		COMBINATION WALL MOUNTED EXIT/EMERGENCY BATTERY LIGHT WITH DIRECTIONAL ARROW. SHADING INDICATES FACE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)
	SHADING INDICATES LUMINAIRE ON EMERGENCY CIRCUIT OR WITH BATTERY BACKUP		CEILING FAN - NUMBER OF BLADES IN SCHEDULE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		EMERGENCY BATTERY LIGHT (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)
	LINE INDICATE ORIENTATION OF LUMINAIRE, WHERE INDICATED		THEATER SPOT LIGHT (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		ABOVE GRADE LUMINAIRE (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)
	UNDERCABINET LIGHT (# INDICATES LUMINAIRE NUMBER IN SCHEDULE)		PRIMARY DAYLIGHT ZONE BOUNDARY		POLE LUMINAIRE(S) (#P AND #S INDICATE POLE AND LUMINAIRE NUMBERS IN RESPECTIVE SCHEDULES)
	ARROW INDICATES WALL WASH LUMINAIRE AIMING		SECONDARY DAYLIGHT ZONE BOUNDARY		LIGHTING CONTROL - FLUSH MOUNTED
	SINGLE POLE SWITCH		LIGHTING CONTROL ZONE BOUNDARY		LIGHTING RELAY - SURFACE MOUNTED
	LOW VOLTAGE SWITCH/CONTROL		SIMPLEX RECEPTACLE		DIMMING/RELAY PANEL
	DOUBLE POLE SWITCH		DUPLEX RECEPTACLE		DISTRIBUTION PANEL, SWITCHBOARD, OR MOTOR CONTROL CENTER
	3-WAY SWITCH		G.T.U. INDICATES TAMPER RESISTANT TYPE. "U" SUBSCRIPT INDICATES COMBINATION USB CHARGING STATION		TRANSFORMER
	4-WAY SWITCH		AUTOMATICALLY CONTROLLED DUPLEX RECEPTACLE		AUTOMATIC TRANSFER SWITCH
	DOOR SWITCH		ISOLATED GROUND DUPLEX RECEPTACLE		ENCLOSED CIRCUIT BREAKER
	MOMENTARY CONTACT SWITCH		HOSPITAL GRADE DUPLEX RECEPTACLE		SINGLE PHASE MAGNETIC MOTOR STARTER
	TIMER SWITCH		RED DUPLEX RECEPTACLE		THREE PHASE MAGNETIC MOTOR STARTER
	SINGLE POLE MANUAL MOTOR STARTER WITH THERMAL OVERLOAD AND PILOT LIGHT		DUPLEX RECEPTACLE - SPLIT WIRED		COMBINATION MAGNETIC STARTER/DISCONNECT
	SWITCH AND FUSE		AUTOMATICALLY CONTROLLED DUPLEX RECEPTACLE - SPLIT WIRED		SAFETY SWITCH (FUSED UNLESS OTHERWISE NOTED) "A"=AMP RATING, "B"=POLES, "C"=FUSE SIZE, "D"=NEMA ENCLOSURE, "F"=FUSE SIZE, "M"=MFG REC. RECOMMENDATIONS AND "N"=NON-FUSE
	MANUAL DIMMER OR FAN SPEED CONTROL ("F" INDICATES FAN SPEED CONTROL)		DRIVER RECEPTACLE NEMA 14-30 (125/250V 30A)		MOTOR
	CEILING MOUNTED OCCUPANCY SENSOR (# INDICATES FIXTURE NUMBER IN SCHEDULE)		SPECIAL PURPOSE RECEPTACLE (NEMA CONFIGURATION AS NOTED)		PULL BOX
	WALL MOUNTED OCCUPANCY SENSOR/SWITCH (# INDICATES FIXTURE NUMBER IN SCHEDULE)		HORIZONTAL MOUNTED DUPLEX RECEPTACLE		JUNCTION BOX ("F" INDICATES FLOOR, "C" INDICATES CEILING)
	PUSH BUTTON STATION		RANGE RECEPTACLE NEMA 14-50 (125/250V 50A)		BRANCH CIRCUIT
	PHOTOCELL CEILING MOUNTED		WELDER RECEPTACLE NEMA 6-50 (250V 50A)		BRANCH CIRCUIT - CONCEALED BELOW FLOOR (UNDERGROUND IF EXTERIOR)
	PHOTOCELL WALL MOUNTED		DOUBLE DUPLEX RECEPTACLE		HOMERUN TO PANEL (NUMBER OF ARROWS INDICATES NUMBER OF CIRCUITS)
	TIME SWITCH		(1) DUPLEX, (1) DUPLEX AUTOMATICALLY CONTROLLED		SPECIAL PURPOSE HOMERUN AS INDICATED
	RELAY		ISOLATED GROUND DOUBLE DUPLEX RECEPTACLE		CONDUIT SEAL
	EMERGENCY LIGHTING RELAY		RED DOUBLE DUPLEX RECEPTACLE		CIRCUIT DOWN
	LIGHTING CONTACTOR		RECEPTACLE IN AV BACKBOX		CIRCUIT UP
	COMBINATION POWER/DATA FLOOR OUTLET ("F" INDICATES DEVICE TYPE IN SCHEDULE)		WALL CLOCK HANGER RECEPTACLE		CONDUIT STUB-OUT
	COMBINATION POWER/AV FLOOR OUTLET ("F" INDICATES DEVICE TYPE IN SCHEDULE)		CEILING MOUNTED DUPLEX RECEPTACLE		CIRCUIT BREAK
	COMBINATION POWER/DATA/AV FLOOR OUTLET ("F" INDICATES DEVICE TYPE IN SCHEDULE)		CEILING MOUNTED DOUBLE DUPLEX RECEPTACLE		CORD AND PLUG
	COMBINATION POWER/DATA/AV TABLE TOP OUTLET ("F" INDICATES DEVICE TYPE IN SCHEDULE)		CEILING MOUNTED RED DUPLEX RECEPTACLE		LIGHTING CONTROL TYPE. SEE LIGHTING CONTROL SCHEDULE
	MULTI-OUTLET ASSEMBLY - LENGTH AS INDICATED		CEILING MOUNTED SPECIAL PURPOSE RECEPTACLE		POWER FLOOR OUTLET ("F" INDICATES DEVICE TYPE IN SCHEDULE)
	MECH EQUIPMENT WITH ELEC CONNECTION SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE		CEILING MOUNTED SIMPLEX RECEPTACLE		BRANCH CIRCUIT FEEDER TAG. SEE BRANCH CIRCUIT FEEDER SCHEDULE
			RECEPTACLE IN CEILING AV BACKBOX		LIGHTING ZONE CIRCUIT DESIGNATION. "XX" INDICATES PANEL NAME, "WF" INDICATES CIRCUIT NUMBER

SYMBOLS INDICATED HERE AND NOT USED IN THE CONTRACT DOCUMENTS DO NOT APPLY TO THIS PROJECT. ADDITIONAL SYMBOLS AND ABBREVIATIONS MAY BE INDICATED IN THE CONTRACT DOCUMENTS.

ABBREVIATIONS					
A AMP	ELEC ELECTRICAL	LTG LIGHTING	REDD REQUIRED		
AC ALTERNATING CURRENT	EMD ESTIMATED MAXIMUM DEMAND	MATV MASTER ANTENNA TELEVISION	RM ROOM		
AFF ABOVE FINISHED FLOOR	EMI ELECTROMAGNETIC INTERFERENCE	MAX MAXIMUM	SBB SECONDARY BONDING BUSBAR		
AJH AUTHORITY HAVING JURISDICTION	EPO EMERGENCY POWER OFF	MCB MAIN CIRCUIT BREAKER	SCHD SCHEDULE		
APPROX APPROXIMATELY	EQUIP EQUIPMENT	MECH MECHANICAL	SIM SIMILAR		
ATS AUTOMATIC TRANSFER SWITCH	EXIST EXISTING	MGB MAIN GROUND BAR	SPD SURGE PROTECTIVE DEVICE		
AUX AUXILIARY	FA FIRE ALARM	MIN MINIMUM	SPECS SPECIFICATIONS		
AV AUDIOVISUAL	FAA FIRE ALARM ANNUNCIATOR PANEL	MISC MISCELLANEOUS	SS STAINLESS STEEL		
AVG AVERAGE	FACP FIRE ALARM CONTROL PANEL	MLO MAIN LUGS ONLY	STD STANDARD		
AWG AMERICAN WIRE GAUGE	FB FLOOR BOX	MTD MOUNTED	SWR SWITCHGEAR		
BMCS BUILDING MANAGEMENT CONTROL SYSTEMS	FL FLOOR	MTG MOUNTING	SWBD SWITCHBOARD		
BLDG BUILDING	FLA FULL LOAD AMPS	N1 NEMA 1 ENCLOSURE	SWI SWITCH		
C CONDUIT	FT FEET	N3R NEMA 3R ENCLOSURE	TELECOM TELECOMMUNICATIONS		
CATV CABLE TELEVISION	FSAE FIRE SERVICE ACCESS ELEVATOR	N4X NEMA 4X ENCLOSURE	TEMP TEMPERATURE		
CB CIRCUIT BREAKER	GALV GALVANIZED	NC NORMALLY CLOSED	TTB TELEPHONE TERMINAL BOARD		
CBTV CLOSED CIRCUIT TELEVISION	GC GENERAL CONTRACTOR	NIC NOT IN CONTRACT	TV TELEVISION		
CKT CIRCUIT	GEC GROUNDING ELECTRODE CONDUCTOR	NO NORMALLY OPEN	TYO TYPICAL		
CL CENTER LINE	GEN GENERATOR	NTS NOT TO SCALE	UG UNDERGROUND		
CLG CEILING	GFCI GROUND FAULT CIRCUIT INTERRUPTER	OC ON CENTER	UNO UNLESS NOTED OTHERWISE		
CRAC COMPUTER ROOM AIR CONDITIONER	GND GROUND	OFCI OWNER FURNISHED CONTRACTOR INSTALLED	UPS UNINTERRUPTIBLE POWER SUPPLY		
DIA DIAMETER	HP HORSEPOWER	PB PULLBOX	VA VOLT-AMPS		
DISC DISCONNECT	HZ HERTZ	PBB PRIMARY BONDING BUSBAR	W WATT		
DIST DISTRIBUTION	IB JUNCTION BOX	PDU POWER DISTRIBUTION UNIT	XFMR TRANSFORMER		
DN DOWN	IC INTERCOM	PERP PERPENDICULAR			
DWG DRAWING	ISB JUNCTION BOX	PV POST INDICATOR VALVE			
EC ELECTRICAL CONTRACTOR	KCMIL THOUSAND CIRCULAR MILS	PNL PANEL			
EGG ELECTRICAL GROUND BAR	KV KILOVOLT AMPERE	PWR POWER			
	KW KILOWATT				

- ### GENERAL NOTES
- INSTALL GREEN INSULATED GROUND WIRE WITH EACH LIGHTING, RECEPTACLE, AND EQUIPMENT BRANCH CIRCUIT.
 - PROVIDE A DEDICATED NEUTRAL CONDUCTOR FOR EACH BRANCH CIRCUIT REQUIRING A NEUTRAL, UNLESS OTHERWISE NOTED.
 - CONCEAL CONDUITS INSTALLED IN NEW WALLS, EXISTING STUD WALLS AND IN AREAS WITH SUSPENDED CEILING.
 - SPECIFICATIONS LIST ACCEPTABLE WRITING METHODS AND MATERIALS. OTHER WRITING METHODS AND MATERIALS NOT LISTED IN THE SPECIFICATIONS (SUCH AS MC CABLE, ETC.) ARE NOT ACCEPTABLE.
 - SEAL ELECTRICAL PENETRATIONS IN MECHANICAL AND ELECTRICAL ROOMS ABOVE OCCUPIED SPACES TO REDUCE NOISE TRANSMISSION.
 - SEAL PENETRATIONS IN FIRE RATED CONSTRUCTION TO MAINTAIN RATINGS.
 - LABELING FOR PANELBOARD DIRECTORIES, FIRE ALARM PANEL PROGRAMMING, ETC., SHALL USE ROOM NUMBERS ASSIGNED BY OWNER AND NOT ROOM NUMBERS LISTED ON DRAWINGS. LABELS ON PANELBOARD DIRECTORY SHALL INCLUDE A DESCRIPTION OF LOAD SUCH AS LIGHTS, RECEPTACLES, MECHANICAL UNIT LOCATIONS, ETC.
 - PROVIDE POWER CONNECTION TO CONTROL PANELS, TRANSFORMERS AND OTHER ITEMS FURNISHED BY MECHANICAL CONTRACTOR FOR HVAC CONTROL. COORDINATE LOCATIONS OF DEVICES REQUIRING POWER CONNECTIONS WITH MECHANICAL CONTRACTOR.

- ### DEMOLITION NOTES
- THE OWNER SHALL HAVE FIRST SALVAGE RIGHTS TO ALL FIXTURES, DEVICES AND EQUIPMENT REMOVED. COORDINATE WITH OWNER PRIOR TO DEMOLITION.
 - REPAIR OR REPLACE BUILDING ELEMENTS WHICH ARE DAMAGED AS PART OF DEMOLITION WORK.
 - DEMOLITION DRAWINGS INDICATE FIXTURES, DEVICES AND MAJOR PIECES OF EQUIPMENT WHICH ARE TO BE REMOVED OR RECONNECTED. REMOVE INDICATED ITEMS AND ASSOCIATED ITEMS NOT INDICATED BUT WHICH MUST BE REMOVED TO ACCOMMODATE REMODELING. THE ITEMS INDICATED SPECIFICALLY ON THE DRAWINGS TO BE REMOVED ARE ONLY TO INDICATE IN GENERAL TO THE CONTRACTOR THE AMOUNT OF DEMOLITION WORK REQUIRED. THE CONTRACTOR SHALL VISIT THE SITE TO DETERMINE THE EXTENT OF DEMOLITION REQUIRED AND SHALL BECOME FAMILIAR WITH EXISTING CONDITIONS PRIOR TO THE BID DATE. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.
 - DISCONNECT MECHANICAL EQUIPMENT BEING REMOVED BY MECHANICAL CONTRACTOR. COORDINATE EQUIPMENT REMOVAL LOCATIONS WITH MECHANICAL DRAWINGS.
 - POWER TO EXISTING AREAS NOT BEING REMODELED SHALL BE MAINTAINED AT ALL TIMES EXCEPT FOR SHORT TERM OUTAGES NECESSARY FOR RECONNECTION OF EXISTING CIRCUITS. COORDINATE AND SCHEDULE OUTAGES WITH THE OWNER.
 - COORDINATE DEMOLITION WITH THE WORK OF OTHER TRADES. PROVIDE TEMPORARY POWER AS REQUIRED TO ALLOW THE WORK OF OTHER TRADES TO PROCEED OR AS REQUIRED TO ALLOW THE OWNER TO OCCUPY THE SPACE.

No	Revisions	Date

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, MEP and other appropriate drawings or at site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

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ELECTRICAL SYMBOL LEGEND AND ABBREVIATIONS

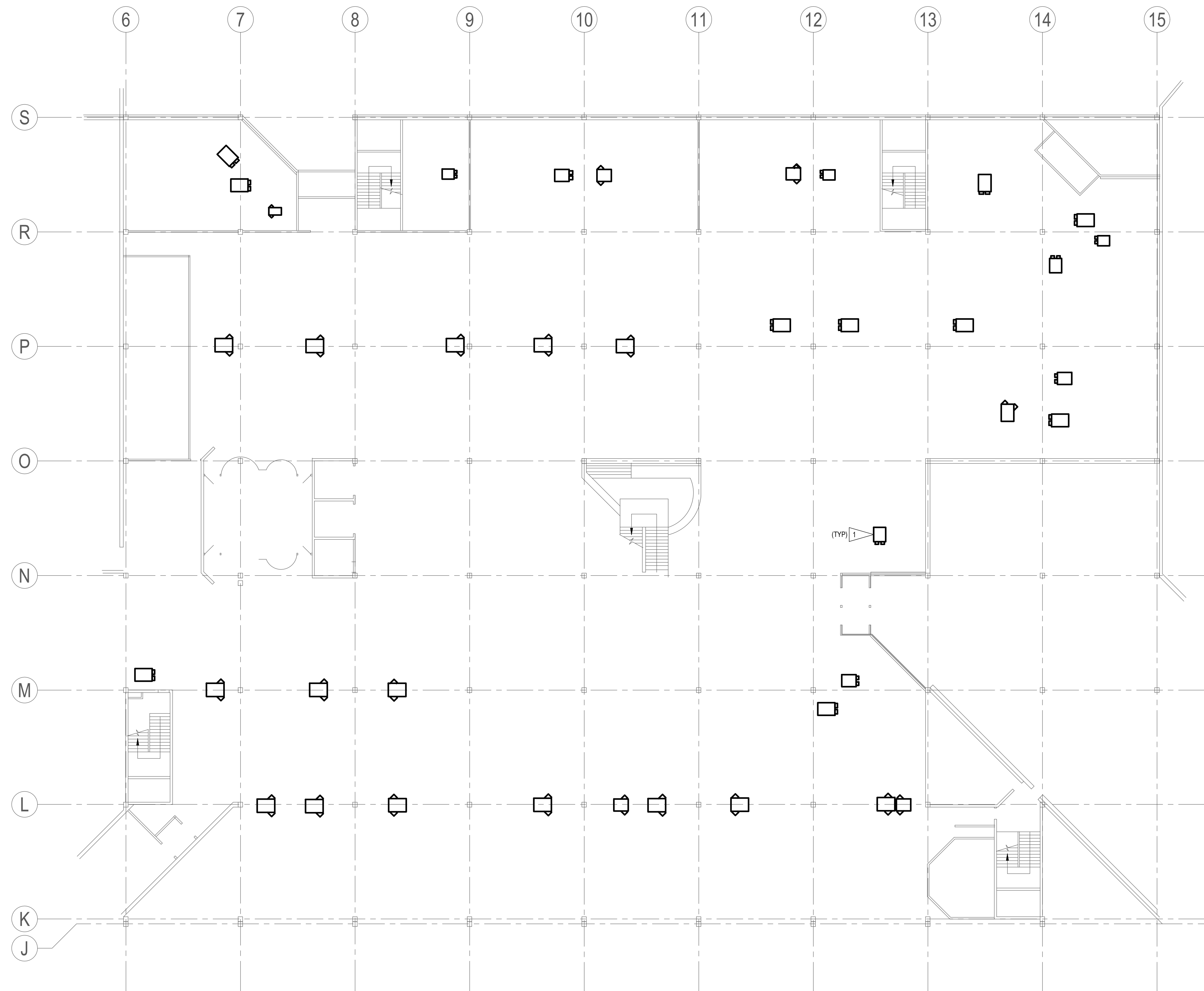
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Designed	File Name
EML	20218745_E000
Drawn	Project No.
OGG	20218745
Checked	Drawing No.
S.H	E000
Date	05/16/2022

C.A. NO. 842 EXPIRES 30 JUNE 2022



FIRST FLOOR PLAN - ELECTRICAL DEMOLITION
 SCALE: 1/16" = 1'-0"
 1
 E011

FLAG NOTES

DISCONNECT EXISTING DUAL DUCT TERMINAL UNIT. RETAIN EXISTING FEEDER TO RECONNECT TO NEW TERMINAL UNIT. REFER TO MECHANICAL DRAWINGS FOR EXACT UNIT LOCATIONS AND QUANTITIES.

No	Revisions	Date

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FIRST FLOOR PLAN - ELECTRICAL DEMOLITION

OCCC MAIN BUILDING AHU REPLACEMENT

OKLAHOMA CITY OKLAHOMA

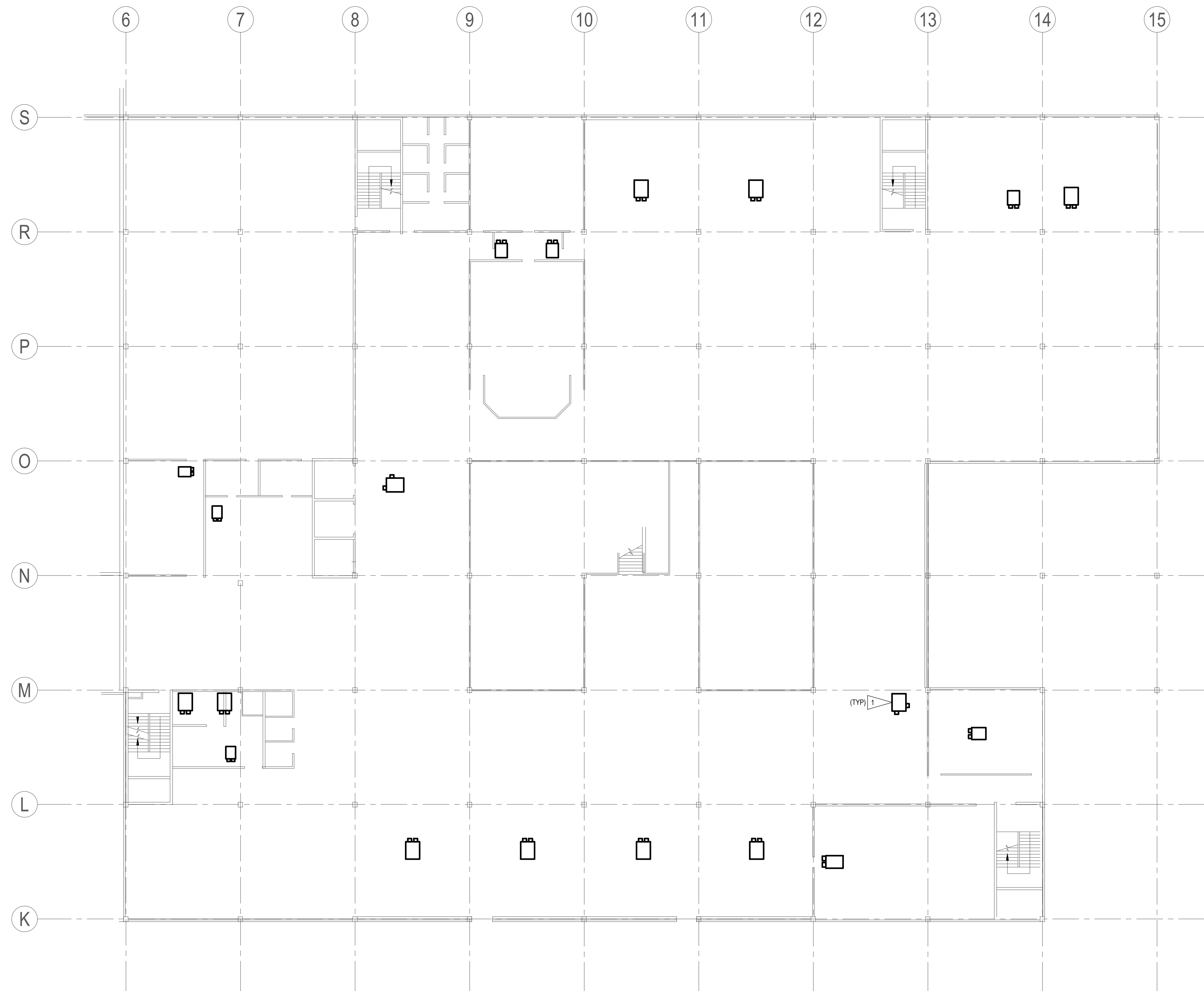


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	Checked	Drawing No.
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C.A. NO. 842 EXPIRES 30 JUNE 2022		20218745_E011 20218745 E011 05/16/2022

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**SECOND FLOOR PLAN -
HVAC DEMOLITION**

SCALE: 1/16" = 1'-0"

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E012

FLAG NOTES

DISCONNECT EXISTING DUAL DUCT TERMINAL UNIT. RETAIN EXISTING FEEDER TO RECONNECT TO NEW TERMINAL UNIT. REFER TO MECHANICAL DRAWINGS FOR EXACT UNIT LOCATIONS AND QUANTITIES.

No	Revisions	Date

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**SECOND FLOOR PLAN -
ELECTRICAL DEMOLITION**

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ODG	20218745
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Date	05/16/2022

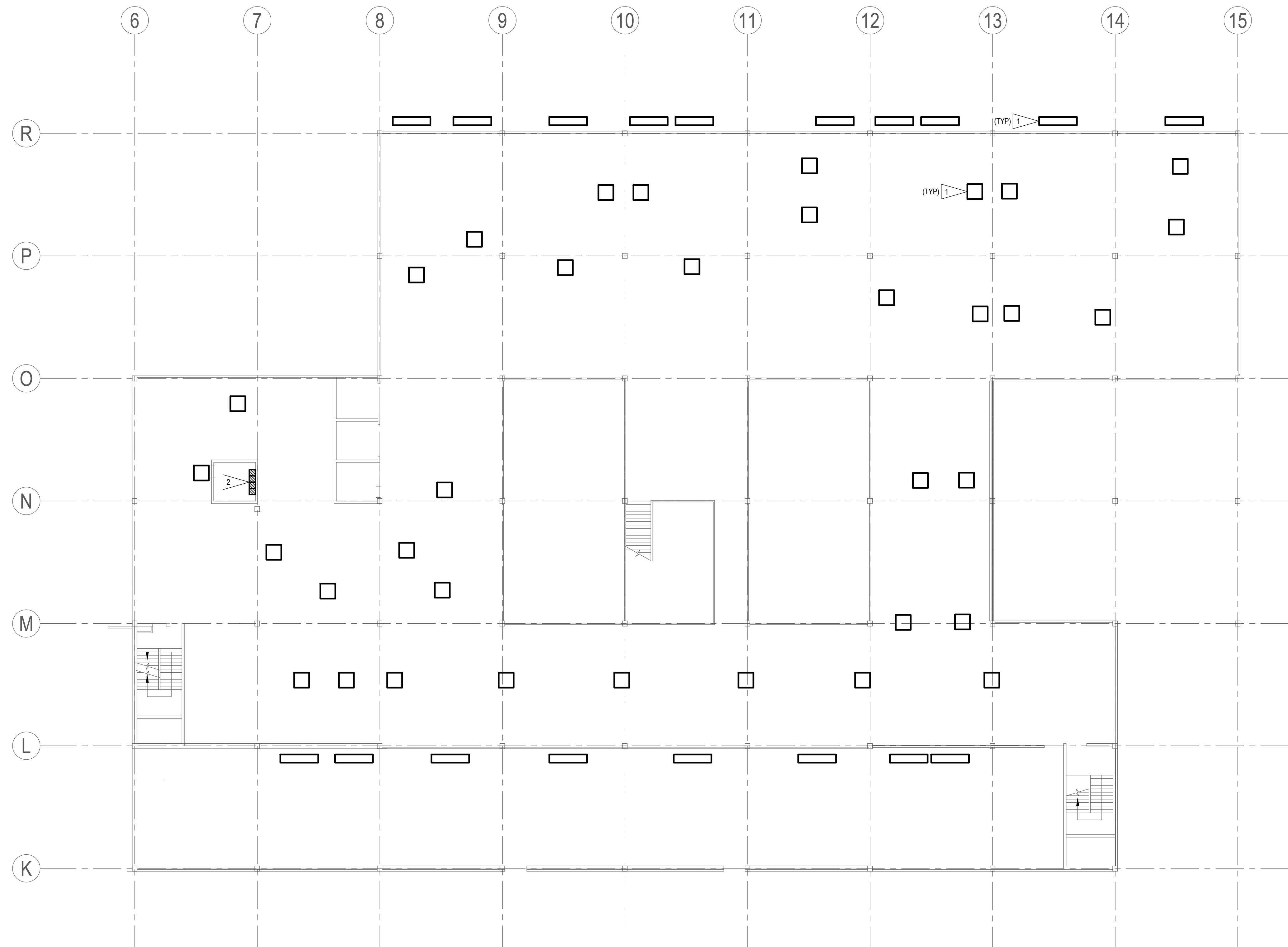


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EXPIRES 05/16/2022

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**THIRD FLOOR PLAN -
ELECTRICAL DEMOLITION**

SCALE: 1/16" = 1'-0"

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E013

FLAG NOTES

- 1 DISCONNECT EXISTING DUAL DUCT TERMINAL UNIT. RETAIN EXISTING FEEDER TO RECONNECT TO NEW TERMINAL UNIT. REFER TO MECHANICAL DRAWINGS FOR EXACT UNIT LOCATIONS AND QUANTITIES.
- 2 REMOVE EXISTING MOTOR CONTROL CENTER (MCC) 1. RETAIN EXISTING 600A FEEDER SERVING THE MOTOR CONTROL CENTER TO RECONNECT TO NEW DISTRIBUTION PANEL.

No	Revisions	Date

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, shop and other appropriate drawings or as site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

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**THIRD FLOOR PLAN -
ELECTRICAL DEMOLITION**

**OCCC
MAIN BUILDING
AHU REPLACEMENT**

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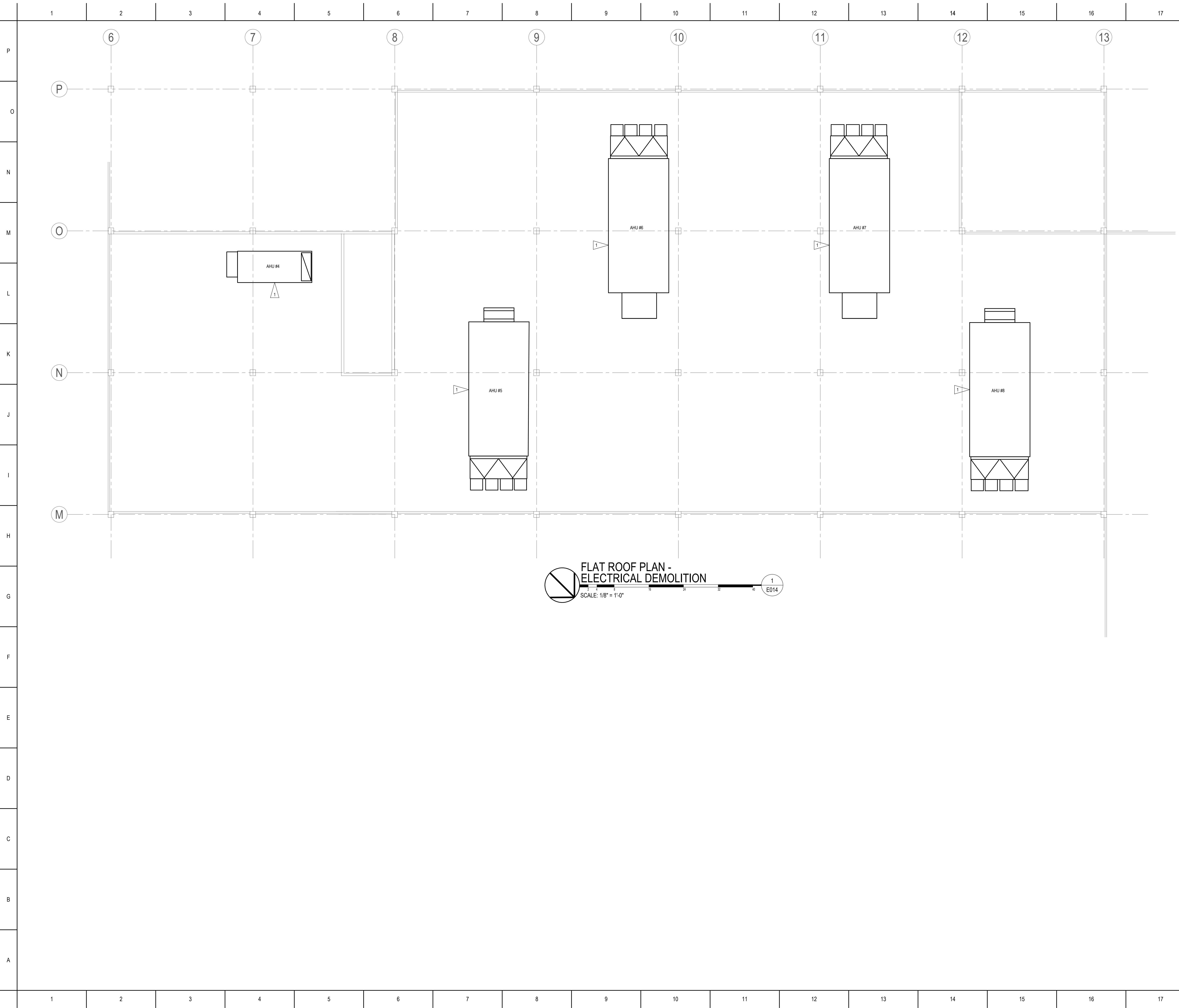


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Date		
05/16/2022		

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EXPIRES 30 JUNE 2022

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FLAT ROOF PLAN - ELECTRICAL DEMOLITION
 SCALE: 1/8" = 1'-0"
 1 E014

FLAG NOTES

DISCONNECT EXISTING AIR HANDLING UNIT.

No	Revisions	Date

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FLAT ROOF PLAN - ELECTRICAL DEMOLITION

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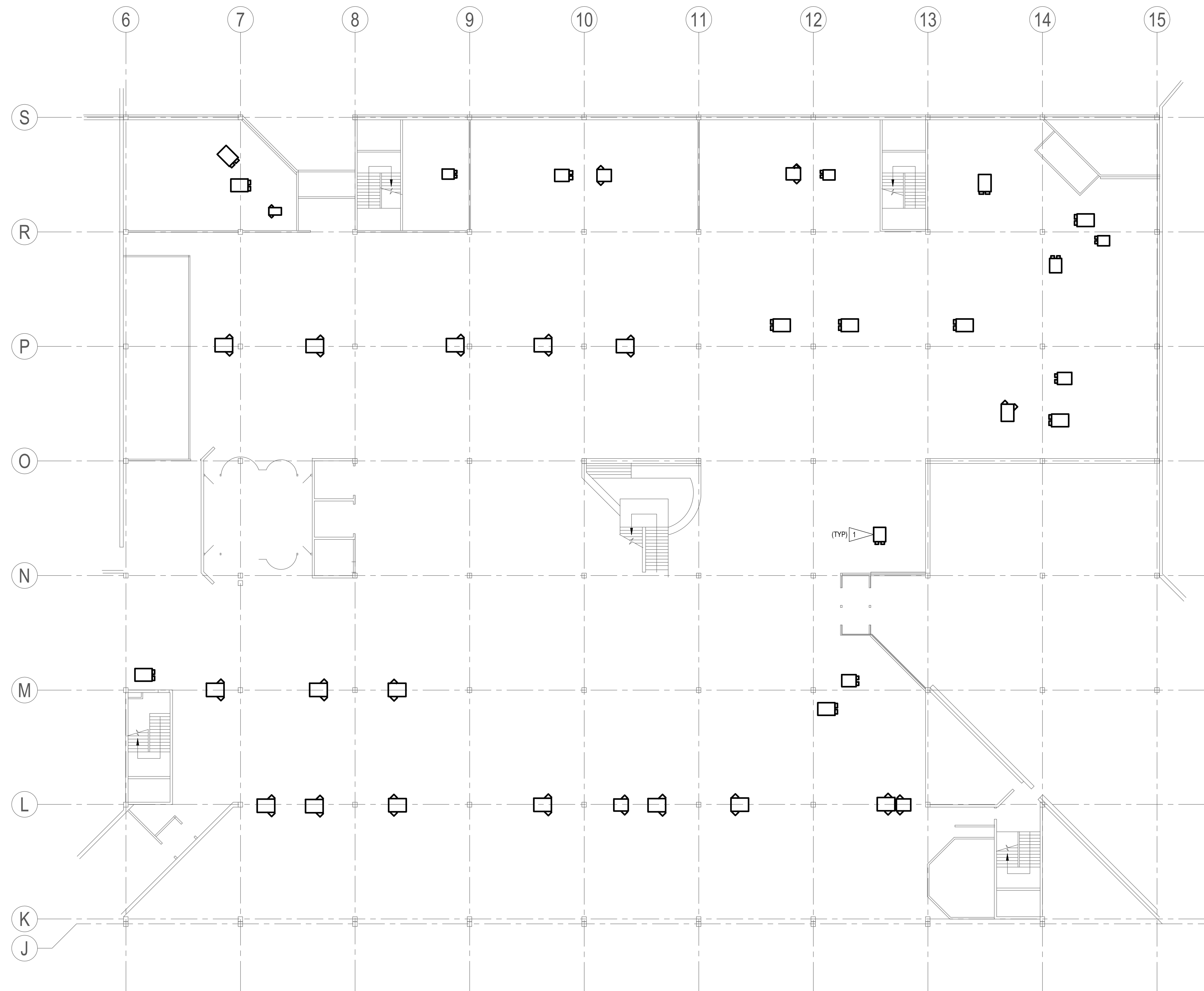
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Date	05/16/2022		

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FIRST FLOOR PLAN - ELECTRICAL
 SCALE: 1/16" = 1'-0"
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FLAG NOTES

CONNECT DUAL DUCT TERMINAL UNIT VIA EXISTING FEEDER. REFER TO MECHANICAL DRAWINGS FOR EXACT UNIT LOCATIONS AND QUANTITIES.

No	Revisions	Date

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FIRST FLOOR PLAN - ELECTRICAL

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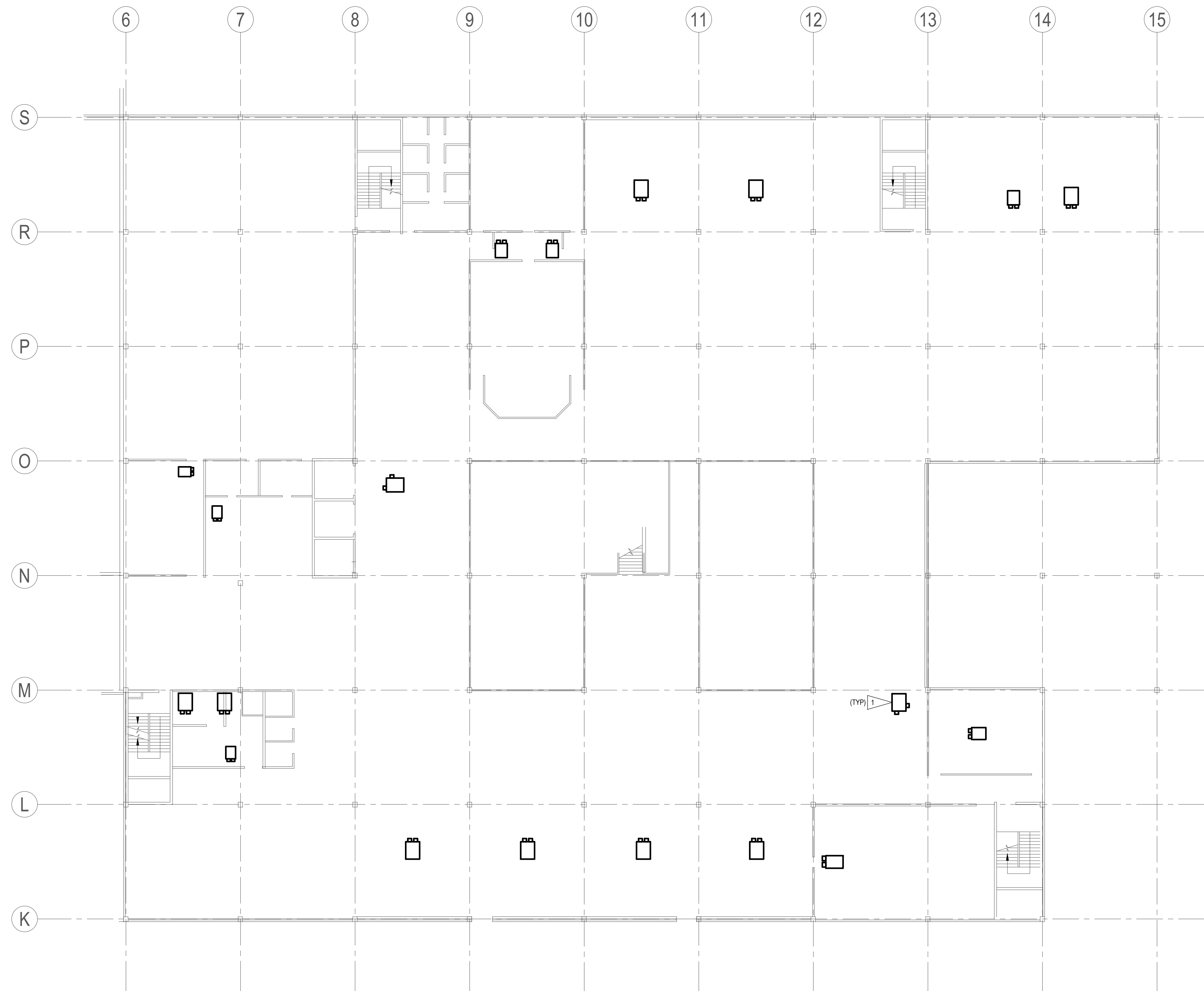
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C.A. NO. 842
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SECOND FLOOR PLAN - ELECTRICAL 1
SCALE: 1/16" = 1'-0" E102

FLAG NOTES

CONNECT DUAL DUCT TERMINAL UNIT VIA EXISTING FEEDER. REFER TO MECHANICAL DRAWINGS FOR EXACT UNIT LOCATIONS AND QUANTITIES.

No	Revisions	Date

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SECOND FLOOR PLAN - ELECTRICAL

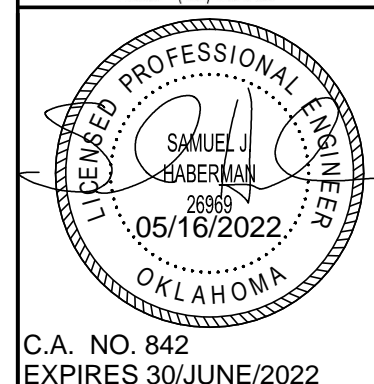
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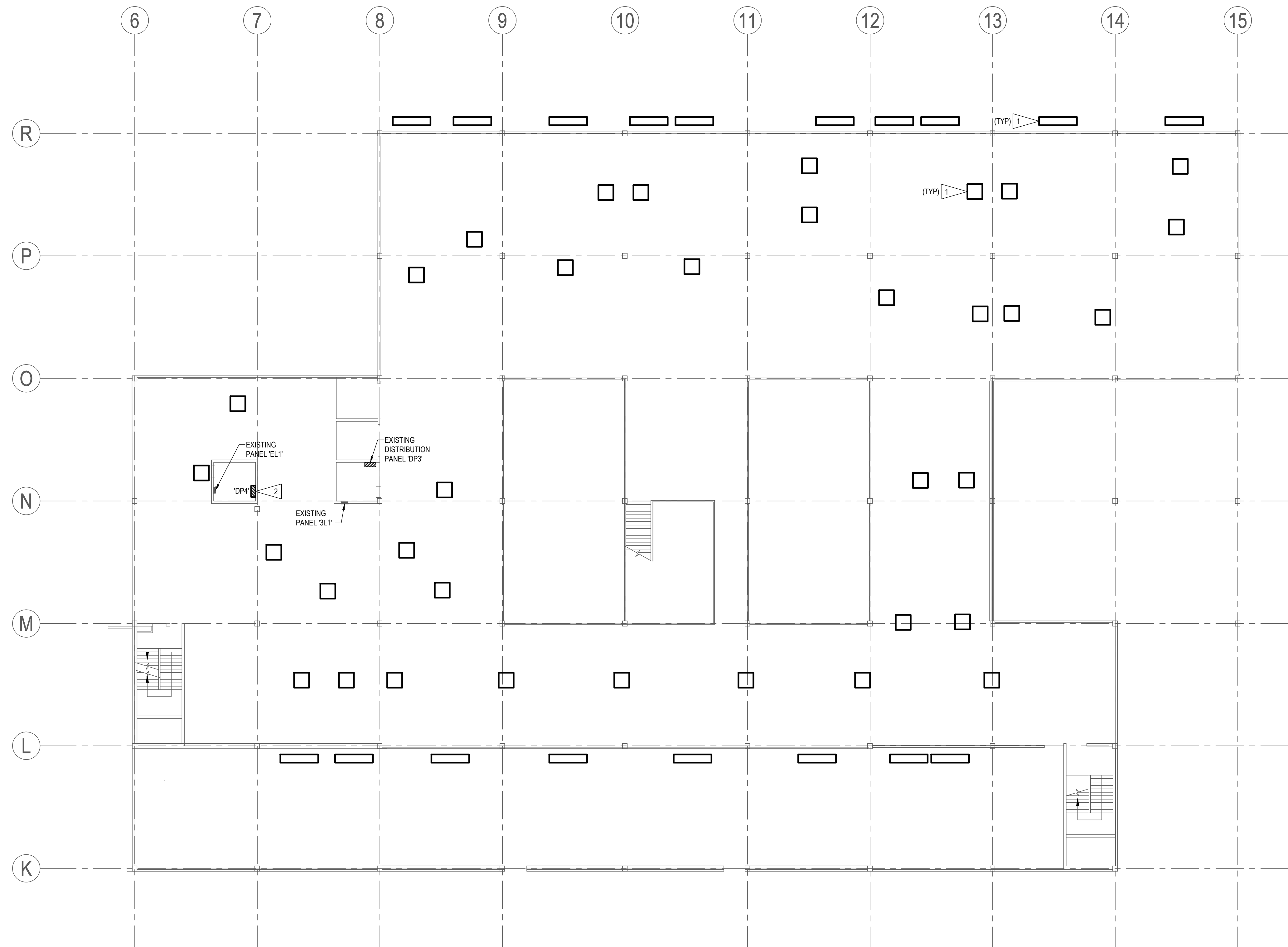
Designed	File Name
EML	20218745_E102
Drawn	Project No.
ODG	20218745
Checked	Drawing No.
S.J.H.	E102
Date	05/16/2022



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

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THIRD FLOOR PLAN - ELECTRICAL
SCALE: 1/16" = 1'-0"
1
E103

FLAG NOTES

- 1 CONNECT DUAL DUCT TERMINAL UNIT VIA EXISTING FEEDER. REFER TO MECHANICAL DRAWINGS FOR EXACT UNIT LOCATIONS AND QUANTITIES.
- 2 CONNECT DISTRIBUTION PANEL VIA EXISTING 600A FEEDER.

No	Revisions	Date

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, shop and other appropriate drawings or as site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

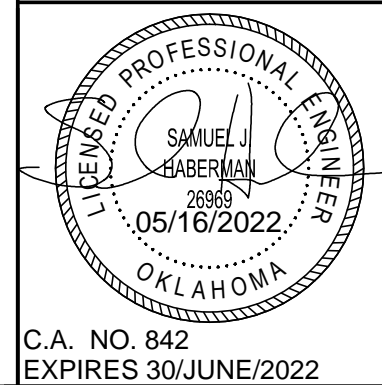
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**THIRD FLOOR PLAN
ELECTRICAL**
**OCCC
MAIN BUILDING
AHU REPLACEMENT**
OKLAHOMA CITY OKLAHOMA



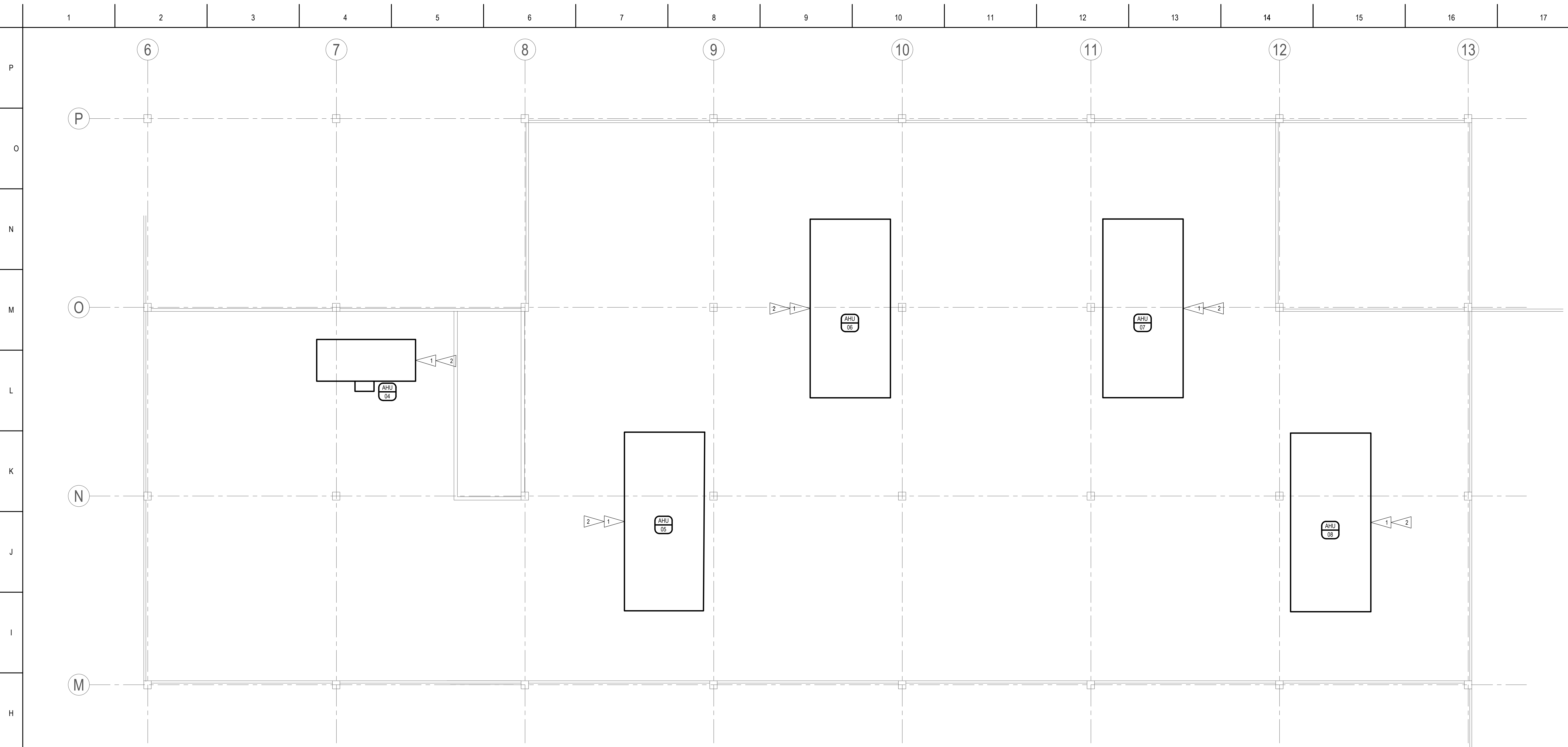
Omaha: 1201 Oak Street, Omaha, Nebraska 68102, Phone: (402) 542-3002
Lincoln: 1800 O Street, Suite 104, Lincoln, Nebraska 68508, Phone: (402) 474-4141
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Designed	File Name
EML	20218745_E103
Drawn	Project No.
ODG	20218745
Checked	Drawing No.
S.J.H.	E103
Date	05/16/2022



C.A. NO. 842
EXPIRES 30/JUNE/2022

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17



FLAT ROOF PLAN - ELECTRICAL
SCALE: 1/8" = 1'-0"

FLAG NOTES

- 1 MOUNT DUCT DETECTORS IN SUPPLY AND RETURN DUCTS OF UNIT. CONNECT AS REQUIRED TO SHUT DOWN UNIT UPON ACTIVATION. COORDINATE WITH MECHANICAL CONTRACTOR.
- 2 PROVIDE MAINTAIN REQUIRED CONNECTIONS TO EXISTING ATRIUM SMOKE CONTROL SYSTEM.

MECHANICAL / ELECTRICAL COORDINATION SCHEDULE													
ABBREVIATIONS:													
A	AMPS	C	COMBINATION STARTER AND SAFETY SWITCH	S	SWITCH	N1	NEMA 1						
ENCL	ENCLOSURE	CB	CIRCUIT BREAKER	SF	SWITCH AND FUSTAT	N3R	NEMA 3R						
HP	HORSEPOWER	CP	CONTROL PANEL	SS	SAFETY SWITCH	N4X	NEMA 4X						
KW	KILOWATTS	C-P	CORD AND PLUG	T	LINE VOLTAGE THERMOSTAT								
PH	PHASE	I	INTEGRAL WITH EQUIPMENT	VFC	VARIABLE FREQUENCY CONTROLLER	SCCR	SHORT CIRCUIT CURRENT RATING						
V	VOLTAGE	NF	NON-FUSED	EC	ELECTRICAL CONTRACTOR								
W	WATTS	OS	OCCUPANCY SENSOR	MEC	MECHANICAL CONTRACTOR								

MARK	DESCRIPTION	LOAD	ELECTRICAL SYSTEM			DISCONNECT			LINE VOLTAGE CONTROLLER			AVAILABLE FAULT CURRENT (AMPS)	REMARKS		
			V	PH	FEEDER OR BRANCH CIRCUIT	PANEL - CIRCUIT	FURNISHED BY/ INSTALLED BY	TYPE	RATING (AMPS)	ENCL	FURNISHED BY/ INSTALLED BY			TYPE	ENCL
AHU-04	AIR HANDLING UNIT	27 A	480	3	40F3	DP3-6	EC/EC	SS	30	N3R	MC-	-	-	9000	2
AHU-04	AIR HANDLING UNIT GFI RECEPTACLE	8 A	120	1	20F2	SL1	-	-	-	-	-	-	-	-	1
AHU-05	AIR HANDLING UNIT RETURN FAN	22 A	480	3	30F3	DP4-1	EC/EC	SS	30	N3R	MC-	-	-	13000	
AHU-05	AIR HANDLING UNIT SUPPLY FAN	126 A	480	3	150F3	DP4-2	EC/EC	SS	200	N3R	MC-	-	-	18000	
AHU-05	AIR HANDLING UNIT LIGHTS AND GFI RECEPTACLE	8 A	120	1	20F2	EL1-1	-	-	-	-	-	-	-	-	
AHU-05	AIR HANDLING UNIT CONTROLLER	120	1	20F2	EL1-3	-	-	-	-	-	-	-	-	-	
AHU-06	AIR HANDLING UNIT RETURN FAN	22 A	480	3	30F3	DP4-3	EC/EC	SS	30	N3R	MC-	-	-	9000	
AHU-06	AIR HANDLING UNIT SUPPLY FAN	126 A	480	3	150F3	DP4-4	EC/EC	SS	200	N3R	MC-	-	-	13000	
AHU-06	AIR HANDLING UNIT LIGHTS AND GFI RECEPTACLE	8 A	120	1	20F2	EL1-6	-	-	-	-	-	-	-	-	
AHU-06	AIR HANDLING UNIT CONTROLLER	120	1	20F2	EL1-7	-	-	-	-	-	-	-	-	-	
AHU-07	AIR HANDLING UNIT RETURN FAN	22 A	480	3	30F3	DP4-5	EC/EC	SS	30	N3R	MC-	-	-	7000	
AHU-07	AIR HANDLING UNIT SUPPLY FAN	126 A	480	3	150F3	DP4-6	EC/EC	SS	200	N3R	MC-	-	-	10000	
AHU-07	AIR HANDLING UNIT LIGHTS AND GFI RECEPTACLE	8 A	120	1	20F2	EL1-9	-	-	-	-	-	-	-	-	
AHU-07	AIR HANDLING UNIT CONTROLLER	120	1	20F2	EL1-11	-	-	-	-	-	-	-	-	-	
AHU-08	AIR HANDLING UNIT RETURN FAN	22 A	480	3	30F3	DP4-7	EC/EC	SS	30	N3R	MC-	-	-	6000	
AHU-08	AIR HANDLING UNIT SUPPLY FAN	126 A	480	3	150F3	DP4-8	EC/EC	SS	200	N3R	MC-	-	-	9000	
AHU-08	AIR HANDLING UNIT LIGHTS AND GFI RECEPTACLE	8 A	120	1	20F2	EL1-4	-	-	-	-	-	-	-	-	
AHU-08	AIR HANDLING UNIT CONTROLLER	120	1	20F2	EL1-6	-	-	-	-	-	-	-	-	-	

GENERAL NOTES:

- VERIFY COORDINATE RATINGS FOR EQUIPMENT SUPPLIED BY THE SELECTED MANUFACTURER. WHERE RATINGS ARE OTHER THAN AS REQUIRED FOR SPECIFIED UNIT, DISCONNECTS, MOTOR STARTERS, OVERCURRENT DEVICES AND RELATED REVISIONS SHALL BE PROVIDED ACCORDINGLY. THE CONTRACTOR THAT FURNISHES EQUIPMENT WITH RATINGS OTHER THAN AS NOTED SHALL BE RESPONSIBLE FOR COORDINATION AND COSTS FOR REVISIONS TO ACCOMMODATE SELECTED EQUIPMENT.
- SHORT CIRCUIT CURRENT RATING (SCCR) OF EQUIPMENT SHALL BE EQUAL TO OR GREATER THAN THE AVAILABLE FAULT CURRENT LISTED. SHORT CIRCUIT CURRENT RATING APPLIES TO EQUIPMENT AND DISCONNECT.
- FRACTIONAL HORSEPOWER SINGLE PHASE MOTORS SHALL BE PROVIDED WITH INTEGRAL OVERLOAD PROTECTION.
- DISCONNECTS SHALL BE FUSIBLE UNLESS NOTED OTHERWISE.
- ELECTRICAL CONTRACTOR SHALL PROVIDE CIRCUIT TO EQUIPMENT AS INDICATED.
- WHERE DISCONNECT IS NOT INDICATED ON PLANS, LOCATE AT EQUIPMENT PER NEC.

REMARKS:

- PROVIDE (1) GE THOB 20A1P CIRCUIT BREAKER IN EXISTING SPACE WITHIN PANEL 3L1. EXISTING PANEL IS GE NLAB SERIES.
- PROVIDE (1) GRASP CIRCUIT BREAKER IN EXISTING PANEL 0P5. REMOVE EXISTING SPARE CIRCUIT BREAKERS TO ACCOMMODATE NEW CIRCUIT BREAKER. CONNECT TO SERVE AHU-04. EXISTING PANEL IS FEDERAL PACIFIC 600A CDP SERIES PANELBOARD.

DISTRIBUTION PANEL DP4				
480/277V	3 PHASE 4 WIRE W/ GND BAR	18282		
600 AMP	MCB	104706		
65000	AMPS AVAILABLE FAULT BREAKER DISTRIBUTION			

CKT #	O/C	REMARKS	LOAD VA	DESCRIPTION
1	35/3		18282	AHU-06 RETURN FANS
2	150/3		104706	AHU-06 SUPPLY FANS
3	35/3		18282	AHU-06 RETURN FANS
4	150/3		104706	AHU-06 SUPPLY FANS
5	35/3		18282	AHU-07 RETURN FANS
6	150/3		104706	AHU-07 SUPPLY FANS
7	35/3		18282	AHU-08 RETURN FANS
8	150/3		104706	AHU-08 SUPPLY FANS
9	40/2		5840	PANEL EL1

LOAD TYPE	CONNECTED	DEMAND FACTOR	DEMAND
RECEPT	3840	NEC	3840
LIGHTING	0	125%	0
MISC	2000	100%	2000
MTR/MTR	491962	100%	491962
			497792 EMD
			0 0% SPARE
			497792 TOTAL VA
			699 [MIN. FEEDER AMPS]

PANEL EL1										
240/120V	1 PHASE 3 WIRE W/ GND BAR	SURFACE MOUNTED								EXISTING MINI POWER CENTER PANEL
50 AMP	MCB									
12 POLES	ONE SECTION	SOURCE								DP4

DESCRIPTION	LOAD VA	REMARKS	O/C	CKT #	PH	CKT #	O/C	REMARKS	LOAD VA	DESCRIPTION
AHU #5 LIGHTS/OUTLET	960		20/1	1	A	2	20/1	EXISTING	RECEPT/LIGHTING THIS ROOM	
AHU #5 CONTROLLER	500		20/1	3	B	4	20/1	NEW BKR	960 AHU #8 LIGHTS/OUTLET	
AHU #6 LIGHTS/OUTLET	960		20/1	5	A	6	20/1	NEW BKR	500 AHU #8 CONTROLLER	
AHU #6 CONTROLLER	500		20/1	7	B	8			SPACE	
AHU #7 LIGHTS/OUTLET	960	NEW BKR	20/1	9	A	10			SPACE	
AHU #7 CONTROLLER	500	NEW BKR	20/1	11	B	12			SPACE	

GENERAL PANEL SCHEDULE NOTES

- FOR PANELS SCHEDULED AS EXISTING TO REMAIN, SCHEDULES ARE PROVIDED TO SHOW NEW BREAKER TYPE AND SIZES.
- SCHEDULES ARE NOT PROVIDED FOR PANELS THAT DO NOT HAVE NEW CIRCUIT INFORMATION.
- PROVIDE NEW BREAKER WHERE NEW BKR IS INDICATED IN REMARKS COLUMN.
- RELOCATE POSITION OF EXISTING BREAKERS AS REQUIRED TO ACCOMMODATE NEW CIRCUITS.
- WHERE EXISTING IS INDICATED IN REMARKS COLUMN, IT IS ANTICIPATED THAT THIS CIRCUIT WILL REMAIN ACTIVE. IF CIRCUIT IS ABANDONED OR REMOVED DURING DEMOLITION, UPDATE PANEL DIRECTORY ACCORDINGLY. 'EXISTING' REMARKS DO NOT RELIEVE CONTRACTOR OF DEMOLITION SCOPE AND REQUIREMENTS IDENTIFIED IN THE DEMOLITION SCOPE.
- PROVIDE AS-BUILT INFORMATION FOR NEW AND EXISTING CIRCUITS.

FEEDER AND BRANCH CIRCUIT SCHEDULE		
MARK	CONDUCTORS AND CONDUIT	
2 WIRE PLUS GROUND		
20F2	2 #12, #12 GND, 1/2" C.	
30F2	2 #10, #10 GND, 3/4" C.	
3 WIRE PLUS GROUND		
20F3	3 #12, #12 GND, 1/2" C.	
30F3	3 #10, #10 GND, 3/4" C.	
40F3	3 #8, #10 GND, 1" C.	
50F3	3 #6, #10 GND, 1" C.	
60F3	3 #6, #10 GND, 1" C.	
70F3	3 #4, #8 GND, 1" C.	
80F3	3 #3, #8 GND, 1 1/4" C.	
90F3	3 #3, #8 GND, 1 1/4" C.	
100F3	3 #2, #8 GND, 1 1/4" C.	
125F3	3 #1, #8 GND, 1 1/2" C.	
150F3	3 #1/0, #6 GND, 1 1/2" C.	

No	Revisions	Date

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, SHOP and other appropriate drawings or as site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

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FLAT ROOF PLAN - ELECTRICAL

OCCC MAIN BUILDING AHU REPLACEMENT

OKLAHOMA CITY OKLAHOMA

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 Oklahoma City: 3247 Brookhaven, Suite 101, Oklahoma City, Oklahoma 73114, Phone: (405) 936-0999
 Des Moines: 405 East Courthouse, Suite 130, Des Moines, Iowa 50309, Phone: (515) 253-0268

Designed	File Name
EML	20218745_E104
Drawn	Project No.
OGG	20218745
Checked	Drawing No.
SJH	E104
Date	05/16/2022

C.A. NO. 842 EXPIRES 30/JUNE/2022

EXHIBIT B

FLAG NOTES

MECHANICAL SYMBOLS			
PLUMBING			
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
---AV---	ACID VENT	---140---	HOT WATER 140"
---AW---	ACID WASTE (ABOVE FLOOR)	---140---	HOT WATER CIRCULATING 140"
---AW---	ACID WASTE (BELOW FLOOR)	G	NATURAL GAS
---	COLD WATER (CW)	---OF---	OVERFLOW STORM DRAIN (ABOVE FLOOR)
---S---	COLD SOFT WATER	---OF---	OVERFLOW STORM DRAIN (BELOW FLOOR)
A	COMPRESSED AIR	---SD---	SANITARY DRAIN (ABOVE FLOOR)
---	EXISTING SANITARY DRAIN (ABOVE FLOOR)	---	SANITARY SEWER (BELOW FLOOR)
---	EXISTING SANITARY SEWER (BELOW FLOOR)	---SS---	SITE STORM SEWER
---S---	EXISTING STORM DRAIN (ABOVE FLOOR)	---S---	STORM DRAIN (ABOVE FLOOR)
---S---	EXISTING STORM DRAIN (BELOW FLOOR)	---S---	STORM DRAIN (BELOW FLOOR)
---SS---	EXISTING SUB SOIL DRAIN	---SS---	SUB SOIL DRAIN
---AW---	EXISTING ACID WASTE (ABOVE FLOOR)	---V---	VENT
---AW---	EXISTING ACID WASTE (BELOW FLOOR)	W	SITE WATER PIPING
---	HOT WATER (HW)	---V---	VACUUM BREAKER
---	HOT WATER CIRCULATING (HWC)	---	GAS COCK
---S---	HOT SOFT WATER	---	RUNNING TRAP
---S---	HOT SOFT WATER RECIRCULATING	CO OR CD	CLEAN OUT
HEATING - VENTILATING - AIR-CONDITIONING			
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
---CWS---	CHILLED WATER SUPPLY	---	AUTOMATIC CONTROL VALVE, 2-WAY
---CWR---	CHILLED WATER RETURN	---	AUTOMATIC CONTROL VALVE, 3-WAY
---PC---	CONDENSATE OR BOILER FEED PUMP DISCHARGE	---	PRESSURE REGULATING VALVE (PRV)
---CS---	CONDENSER WATER SUPPLY FROM TOWER	---	PIPE IN SLEEVE
---CR---	CONDENSER WATER RETURN TO TOWER	---	VALVE IN VERTICAL PIPE
---CD---	COIL OR EQUIPMENT DRAIN	---	F AND T TRAP CAP LBSHR
---GS---	GLYCOL SUPPLY	---	BUCKET TRAP CAP LBSHR
---GR---	GLYCOL RETURN	---	AIR QUALITY SENSOR
---FOS---	FUEL OIL SUPPLY	---	AQUASTAT
---FOR---	FUEL OIL RETURN	---	CO2 SENSOR
---FOV---	FUEL OIL VENT	---	HUMIDISTAT
---G---	NATURAL GAS	---	REMOTE SENSOR
---HPWS---	HEAT PUMP WATER SUPPLY	---	THERMOSTAT
---HPWR---	HEAT PUMP WATER RETURN	---	THERMOSTAT WITH REMOTE SENSOR
---HPR---	HIGH PRESSURE CONDENSATE RETURN	---	SOLENOID VALVE (REFRIGERANT)
---HPS---	HIGH PRESSURE STEAM	---	THERMOSTATIC EXPANSION VALVE (REFRIGERANT)
---HWS---	HOT WATER SUPPLY	---	SIGHT GLASS
---HWR---	HOT WATER RETURN	---	MANUAL AIR VENT
---LPR---	LOW PRESSURE CONDENSATE RETURN	---	PRESSURE OR TEMPERATURE MEASURING POINTS
---LPS---	LOW PRESSURE STEAM	---	FLOW SWITCH
---MPR---	MEDIUM PRESSURE CONDENSATE RETURN	---	HEATING RISER
---MPS---	MEDIUM PRESSURE STEAM	---	ACCESS DOOR - SIZE AS SHOWN OR PER SPEC.
---RL---	REFRIGERANT LIQUID	---	EXPANSION LOOP, LENGTH AND DEPTH
---RS---	REFRIGERANT SUCTION	---	FIN/TUBE-TYPE (SHADED AREA INDICATES CAPACITY MBH ELEMENT LOCATION)
---RD---	REFRIGERANT HOT GAS DISCHARGE	---	POINT OF DISCONNECT
B.D.D.	BACK-DRAFT DAMPER (COUNTER BALANCED)	---	NEW TO EXISTING CONNECTION

MECHANICAL SYMBOLS			
PIPING			
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
---	TEE	---	GLOBE VALVE
---	ELBOW	---	PRESS / TEMP TEST PORT
---	UNION	---	GATE VALVE
---	STRAINER WITH BLOW-OFF VALVE	---	CHECK VALVE (ARROW INDICATES FLOW)
---	BALANCING VALVE	---	FLEXIBLE PIPING
---	ISOLATION VALVE (BALL OR BUTTERFLY)	---	AUTOMATIC AIR VENT
---	PRESSURE RELIEF VALVE	---	MANUAL AIR VENT WITH ISOLATION VALVE
---	ELBOW UP	---	
---	ELBOW DOWN	---	

SYMBOLS INDICATED HERE AND NOT USED IN THE CONTRACT DOCUMENTS DO NOT APPLY TO THIS PROJECT. ADDITIONAL SYMBOLS AND ABBREVIATIONS MAY BE INDICATED IN THE CONTRACT DOCUMENTS.

DEMOLITION NOTES:

- THE OWNER SHALL HAVE THE FIRST RIGHT OF SALVAGE FOR ALL MECHANICAL, ELECTRICAL, AND PLUMBING ITEMS BEING REMOVED. IF OWNER DECLINES, THE CONTRACTOR SHALL REMOVE FROM THE PREMISES AND DISPOSE OF PROPERLY. VERIFY OWNER'S INTENT PRIOR TO REMOVAL OR DEMOLITION.
- INFORMATION PERTAINING TO THE EXISTING BUILDING HAS BEEN OBTAINED THROUGH THE BUILDING'S ORIGINAL DRAWINGS WHERE AVAILABLE. REPORT DISCREPANCIES TO THE ARCHITECT/ENGINEER PRIOR TO ANY DEMOLITION. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO COMMENCING WORK.
- COORDINATE SHUT DOWN OF ALL UTILITIES FOR DEMOLITION WORK WITH THE OWNER.
- DISCONNECT AND REMOVE MECHANICAL SYSTEMS, EQUIPMENT, AND COMPONENTS SHOWN HATCHED AND INDICATED TO BE REMOVED. PIPING TO BE REMOVED - REMOVE PORTION OF PIPING INDICATED TO BE REMOVED AND CAP REMAINING PIPING WITH THE SAME OR COMPATIBLE PIPING MATERIAL.
- IF PIPE OR EQUIPMENT INSULATION TO REMAIN IS DAMAGED IN APPEARANCE OR IS UNSERVICEABLE, REMOVE DAMAGED OR UNSERVICEABLE PORTIONS AND REPLACE WITH NEW PRODUCTS OF EQUAL CAPACITY AND QUALITY.
- CONTRACTOR IS REQUIRED TO VISIT SITE AND FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO BIDDING PROJECT.
- COORDINATE DEMOLITION WITH THE WORK OF OTHER TRADES. PROVIDE TEMPORARY UTILITIES AS REQUIRED TO ALLOW THE WORK OF OTHER TRADES TO PROCEED.

PIPING GENERAL NOTES:

- DO NOT RUN PIPING, PLUMBING, AND DUCTWORK ABOVE ELECTRICAL PANELS OR IN CODE REQUIRED CLEARANCE SPACES. COORDINATE ALL ROUTING WORK WITH ALL OTHER TRADES.
- DO NOT RUN PIPING, PLUMBING, AND DUCTWORK ABOVE OR THROUGH INFORMATION TECHNOLOGY AND DATA CLOSETS, IDF, AND MDF ROOMS. COORDINATE ALL ROUTING WITH ALL OTHER TRADES.
- DRAWINGS, PLANS, SCHEMATICS, AND DIAGRAMS INDICATE THE GENERAL LOCATIONS AND THE ARRANGEMENT OF SYSTEMS. WHEREVER PRACTICAL, INSTALL SYSTEMS AS INDICATED. PROVIDE OFFSETS AND ELEVATION CHANGES TO PIPING, PLUMBING, AND DUCTWORK AS REQUIRED TO COMPLETE THE LAYOUT AND COORDINATION PROCESS AS WELL AS MEET ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.
- PIPING AND EQUIPMENT SHOWN WITH THIN LINES INDICATES EXISTING TO REMAIN. PIPING AND EQUIPMENT SHOWN WITH BOLD LINES INDICATES NEW.
- ALL PIPING INSULATION SHALL MEET THE ENERGY CODE'S INSTALLED R VALUE REQUIREMENTS.
- DIELECTRIC NIPPLES OR FLANGE INSULATION KITS SHALL BE UTILIZED FOR ALL DISSIMILAR PIPE CONNECTIONS. DIELECTRIC UNIONS WILL NOT BE ACCEPTED.

HVAC GENERAL NOTES:

- DO NOT RUN DUCTWORK, PIPING, AND PLUMBING ABOVE ELECTRICAL PANELS OR IN CODE REQUIRED CLEARANCE SPACES. COORDINATE ALL ROUTING WORK WITH ALL OTHER TRADES.
- DO NOT RUN DUCTWORK, PIPING, AND PLUMBING ABOVE OR THROUGH INFORMATION TECHNOLOGY AND DATA CLOSETS, IDF, AND MDF ROOMS. COORDINATE ALL ROUTING WITH ALL OTHER TRADES.
- DRAWINGS, PLANS, SCHEMATICS, AND DIAGRAMS INDICATE THE GENERAL LOCATIONS AND THE ARRANGEMENT OF SYSTEMS. WHEREVER PRACTICAL, INSTALL SYSTEMS AS INDICATED. PROVIDE OFFSETS AND ELEVATION CHANGES TO DUCTWORK, PIPING, AND PLUMBING AS REQUIRED TO COMPLETE THE LAYOUT AND COORDINATION PROCESS AS WELL AS MEET ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.
- CONTRACTOR SHALL COORDINATE LOCATION OF DUCTWORK IN CEILING SPACE WITH ALL TRADES PRIOR TO FABRICATION AND INSTALLATION OF DUCTWORK.
- FOR GENERAL DUCTWORK CONSTRUCTION, SEE DUCT FITTING DETAILS.
- DUCTWORK AND EQUIPMENT SHOWN WITH THIN LINES INDICATES EXISTING TO REMAIN. DUCTWORK AND EQUIPMENT SHOWN WITH BOLD LINES INDICATES NEW.
- PROVIDE CLEARANCES TO ALL EQUIPMENT AS REQUIRED BY MANUFACTURERS' INSTALLATION AND OPERATION REQUIREMENTS AND/OR BY CODE.
- INSTALL ALL DUCT AND PIPING IN MECHANICAL ROOMS AS HIGH AS POSSIBLE. PROVIDE 7'-0" MINIMUM HIGH ACCESS PATHWAYS TO ALL EQUIPMENT.
- CAP ENDS OF ALL INSTALLED DUCTWORK DURING CONSTRUCTION TO MINIMIZE DIRT, DEBRIS, AND FOREIGN OBJECTS FROM ENTERING THE DUCT SYSTEM.
- COORDINATE SCHEDULE OF SHUTDOWN FOR EXISTING HVAC SYSTEMS, FOR INSTALLATION OF NEW HVAC SYSTEMS, WITH THE OWNER'S REPRESENTATIVE PRIOR TO SHUTDOWN.
- ALL INSULATION SHALL MEET THE ENERGY CODE'S INSTALLED R VALUE REQUIREMENTS.

PRELIMINARY SEQUENCE OF WORK

SEQUENCE AND PHASING OF WORK SHALL BE COORDINATED WITH OWNER. IT IS THE INTENT THAT EACH OF FIVE LARGE AIR HANDLING UNITS INDICATED TO BE REPLACED AND ASSOCIATED DUAL DUCT TERMINALS BE REPLACED SEPARATELY SO THAT THE BUILDING CAN REMAIN OPERATIONAL DURING THE REPLACEMENT PROCESS. COORDINATE SHUT DOWN, REMOVAL AND INSTALLATION OF NEW SYSTEMS WITH OWNER PRIOR TO WORK AND/OR ACQUISITION OF REPLACEMENT EQUIPMENT. ALL WORK SHALL BE COORDINATED WITH THE OWNER'S EDUCATIONAL PROCESS. SUBMIT A SCHEDULE/CALENDAR OF ALL WORK ACTIVITIES FOR OWNER APPROVAL PRIOR TO START OF WORK.

PRELIMINARY SEQUENCE OF WORK

CONTRACTOR SHALL REMOVE CEILING TILES, CEILING SUPPORT GRID AND/OR HARD SURFACE (GYP - BOARD) CEILING AS REQUIRED FOR INSTALLATION / REPLACEMENT OF NEW DUAL DUCT TERMINAL UNITS AND DUCTWORK. REPLACE / REPAIR AND/OR TERMINAL UNITS AND DUCTWORK. REPLACE / REPAIR AND/OR REINSTALL EXISTING OR NEW CEILING TILES, CEILING SUPPORT GRID AND/OR HARD SURFACE CEILING AS REQUIRED TO MATCH EXISTING CEILING.

LEGEND	
---	CONNECTED AHU
---	FLOOR UNIT INSTALLED LOCATION
---	UNIT NUMBER
---	HORIZONTAL MOUNTED DUAL DUCT TERMINAL UNIT
---	VERTICALLY MOUNTED DUAL DUCT TERMINAL UNIT


ABBREVIATIONS			
AFB ABOVE FINISHED FLOOR	DIA DIAMETER	GW GARAGE WASTE	OFCI OWNER FURNISHED CONTRACTOR INSTALLED
AHU AUTHORITY HAVING JURISDICTION	DISC DISCONNECT	HGT HEIGHT	PERP PERIPHERAL
ASHRAE AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS	DIST DISTRIBUTION	HP HORSEPOWER	PV POST INDICATOR VALVE
ASME AMERICAN SOCIETY OF MECHANICAL ENGINEERS	DN DOWN	HVAC HEATING, VENTILATING AND AIR CONDITIONING	PLUG PLUMBING
ASTM STANDARD SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS	DPV DRY PIPE AIR COMPRESSOR	HZ HERTZ HIGH ZONE WET STANDPIPE	PL UNLESS NOTED OTHERWISE
AUX AUXILIARY	DWG DRAWING	IE INVERT ELEVATION	PS POUNDS PER SQUARE FOOT
AV ACID VENT	DX DIRECT EXPANSION	IP INTERNET PROTOCOL	PSI POUNDS PER SQUARE INCH
AVG AVERAGE	EA EXHAUST AIR	IR INFRARED	PVC POLYVINYL CHLORIDE
AWG AMERICAN WIRE GAUGE	EL ELEVATION	KW KILOWATT	PWR POWER
BMS BUILDING MANAGEMENT CONTROL SYSTEM	ELEC ELECTRICAL	LBS POUNDS	RA RETURN AIR
BFP DOUBLE CHECK BACKFLOW PREVENTER	EMS ENERGY MANAGEMENT SYSTEM	LE LOW ZONE WET STANDPIPE	REQD REQUIRED
BLDG BUILDING	EOA ECONOMIZER OUTDOOR AIR	MAX MAXIMUM	RGS RIGID GALVANIZED STEEL
BTU BRITISH THERMAL UNIT PER HOUR	EPO EMERGENCY POWER OFF	MH 1000 TUB/HOUR	RH RELATIVE HUMIDITY
CFM CUBIC FEET PER HOUR	EQUIP EQUIPMENT	MECH MECHANICAL	RLFA RELIEF AIR
CFM CUBIC FEET PER MINUTE	EXHAUST	MIN MINIMUM EFFICIENCY REPORTING VALUE	RM ROOM
CL CENTER LINE	EXIST EXISTING	MM MINIMUM	RO REVERSE OSMOSIS WATER
CLG CEILING	FA FIRE ALARM	MISC MISCELLANEOUS	RPZ REDUCED PRESSURE ZONE BACKFLOW PREVENTER
CLR CLEAR	FO FLOOR CLEAN OUT	MCA MINIMUM OUTDOOR AIR	SA SUPPLY AIR
CPVC CHLORINATED POLYVINYL CHLORIDE	FDC FIRE DEPARTMENT CONNECTION	MTD MOUNTED	SAN SANITARY
CRAC COMPUTER ROOM AIR CONDITIONER	FHC FIRE HOSE CABINET	NC NORMALLY CLOSED	SCHD SCHEDULE
CV CONSTANT VOLUME	FHW FIRE HOSE VALVE	NFPA NATIONAL FIRE PROTECTION ASSOCIATION	SCHW SOFT COLD WATER
DDCV DOUBLE DETECTOR CHECK VALVE ASSEMBLY BACKFLOW PREVENTER	FL FLOOR	NI NOT IN CONTRACT	SHW SOFT HOT WATER
	FT FEET	NO NOT NORMALLY OPEN	SM SIMILAR
	GA GAUGE	NOM NOMINAL	SM SPRINKLER MAIN
	GALV GALVANIZED	NPW NON-POTABLE WATER	SMC SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
	GC GENERAL CONTRACTOR	NTS NOT TO SCALE	SMACNA SPECIFICATIONS
	GEN GENERATOR	OK OUTDOOR AIR	SS STAINLESS STEEL
	GPM GALLONS PER MINUTE	OC ON CENTER	

No	Revisions	Date

MECHANICAL SYMBOL LEGEND AND ABBREVIATIONS

OCCC MAIN BUILDING AHU REPLACEMENT

OKLAHOMA CITY OKLAHOMA



ALVINE Engineering

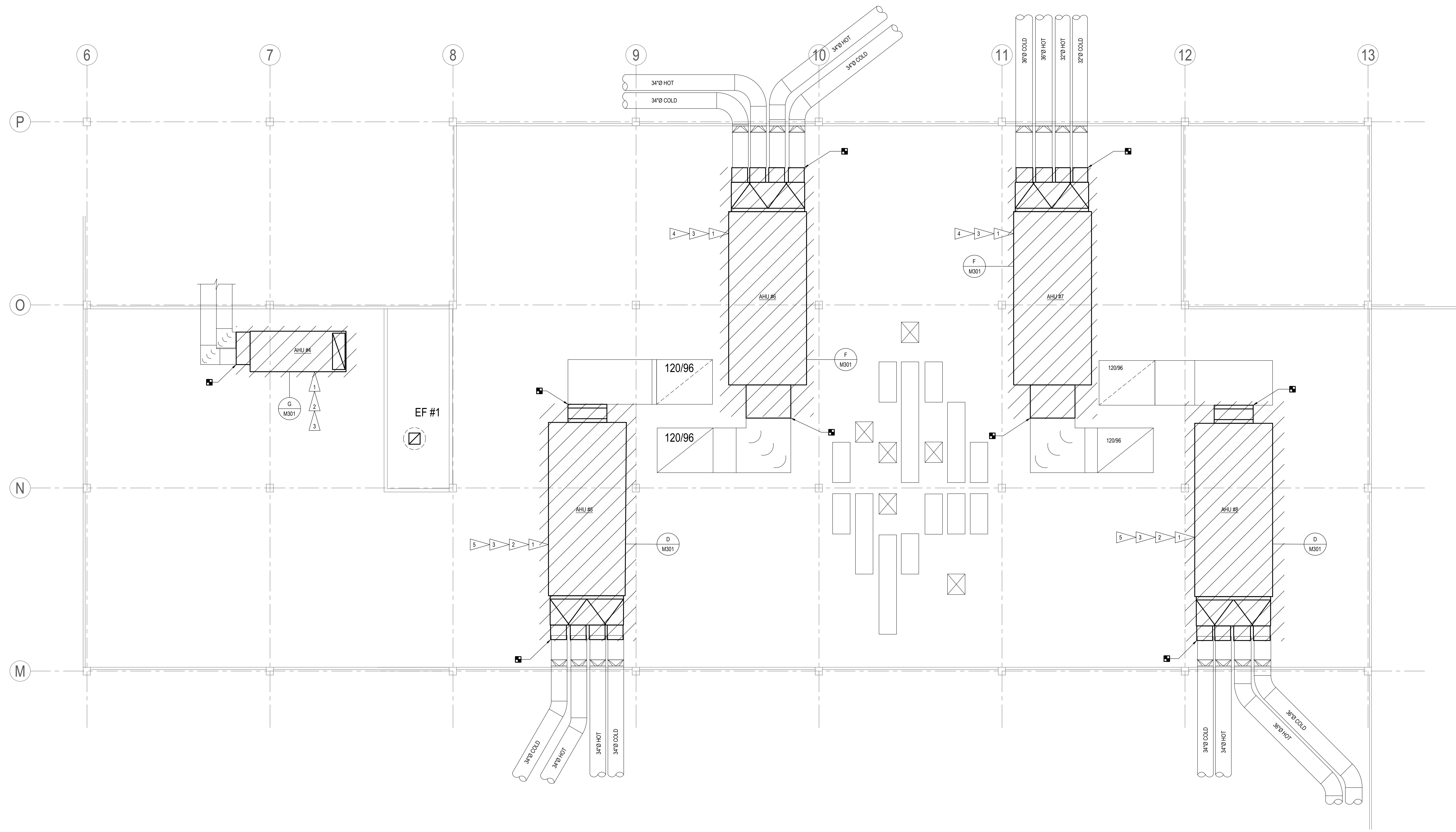
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Designed	LEM	File Name	20218745_M000
Drawn	KMF	Project No.	20218745
Checked	EJK	Drawing No.	M000
Date	05/16/2022		

C.A. NO. 842 05/16/2022 EXPIRES 30/JUNE/2022

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FLAT ROOF PLAN - HVAC DEMOLITION
SCALE: 1/8" = 1'-0"
1 M014

FLAG NOTES

- 1 EXISTING ROOF MOUNTED AIR HANDLING UNIT AND DUCT CONNECTIONS SHOWN HATCHED TO BE REMOVED AND REPLACED. DISCONNECT HWS/ HWR, CWS/CWR PIPING AND ELECTRICAL CONNECTIONS ABOVE ROOF, PRIOR TO UNIT REMOVAL.
- 2 EXISTING ROOF CURB AT AIR HANDLING UNIT TO BE REPLACED. CONTRACTOR TO PROVIDE NEW ROOF CURB FLASHINGS AND COORDINATE NEW ROOF CURB INSTALLATION WITH EXISTING ROOFING CONTRACTOR NO EXCEPTIONS OR SUBSTITUTES.
OKLAHOMA ROOFING, AND SHEET METAL.
1708 S. LOWRY AVENUE
OKLAHOMA CITY, OK, 73129
405 670 1429.
- 3 INSTALL NEW ROOFTOP AHU INDICATED RECONNECT HWS/ HWR, CWS/ CWR PER DETAILS C AND E ON SHEET M301. VERIFY AND COORDINATE EXACT LOCATION. PROVIDE NEW PIPING UNION CONNECTION ABOVE ROOF.
- 4 REPLACE EXISTING ROOF MOUNTED AHU ON EXISTING ELEVATED STEEL PLATFORM. REFER DETAIL FM301.
- 5 REPLACE EXISTING ROOF MOUNTED AHU ON NEW 18" TALL ROOF CURB. REFER DETAIL DM301.

No Revisions Date

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FLAT ROOF PLAN - HVAC DEMOLITION

OCCC MAIN BUILDING AHU REPLACEMENT

OKLAHOMA CITY OKLAHOMA

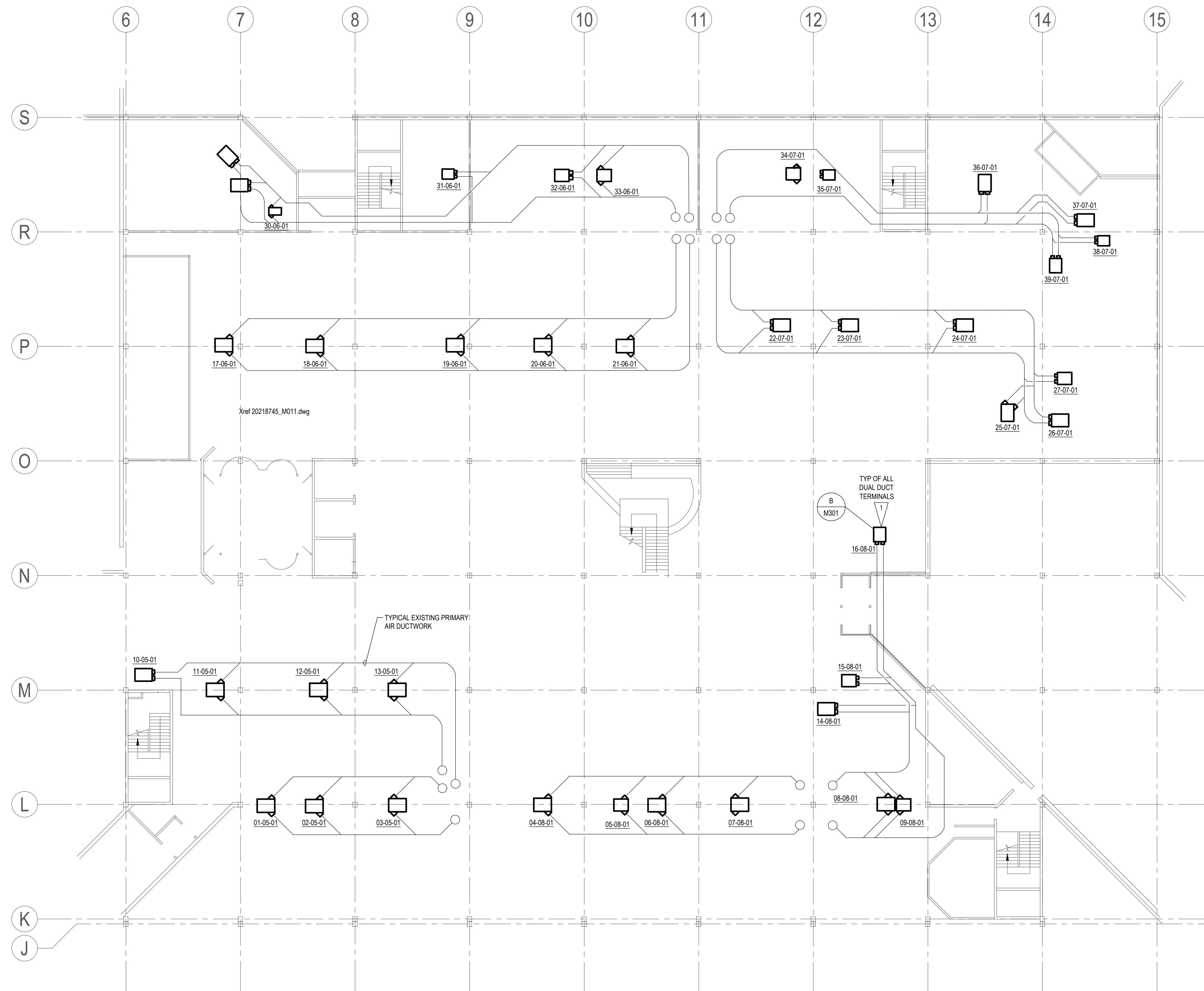


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Designed: LEM Drawn: KMF Checked: EJK Date: 05/16/2022	File Name: 20218745_M014 Project No.: 20218745 Drawing No.: M014		

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FIRST FLOOR PLAN - HVAC
 SCALE: 1/16" = 1'-0"
 1 M101

FLAG NOTES

EXISTING DUAL DUCT TERMINAL TO BE REPLACED. VERIFY EXISTING UNIT EXACT LOCATION AND ORIENTATION TO COORDINATE UNIT REPLACEMENT CONFIGURATION. ASSOCIATED UNIT THERMOSTAT TO BE REPLACED AND WIRED IN EXISTING LOCATION. UNIT TO BE CONNECTED AND INTEGRATED INTO THE EXISTING TRANE BUILDING AUTOMATION SYSTEM. REFER INSTALLATION DETAIL B301.

NO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, ship and other appropriate drawings or as site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

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FIRST FLOOR PLAN - HVAC
OCCC MAIN BUILDING AHU REPLACEMENT
 OKLAHOMA CITY OKLAHOMA



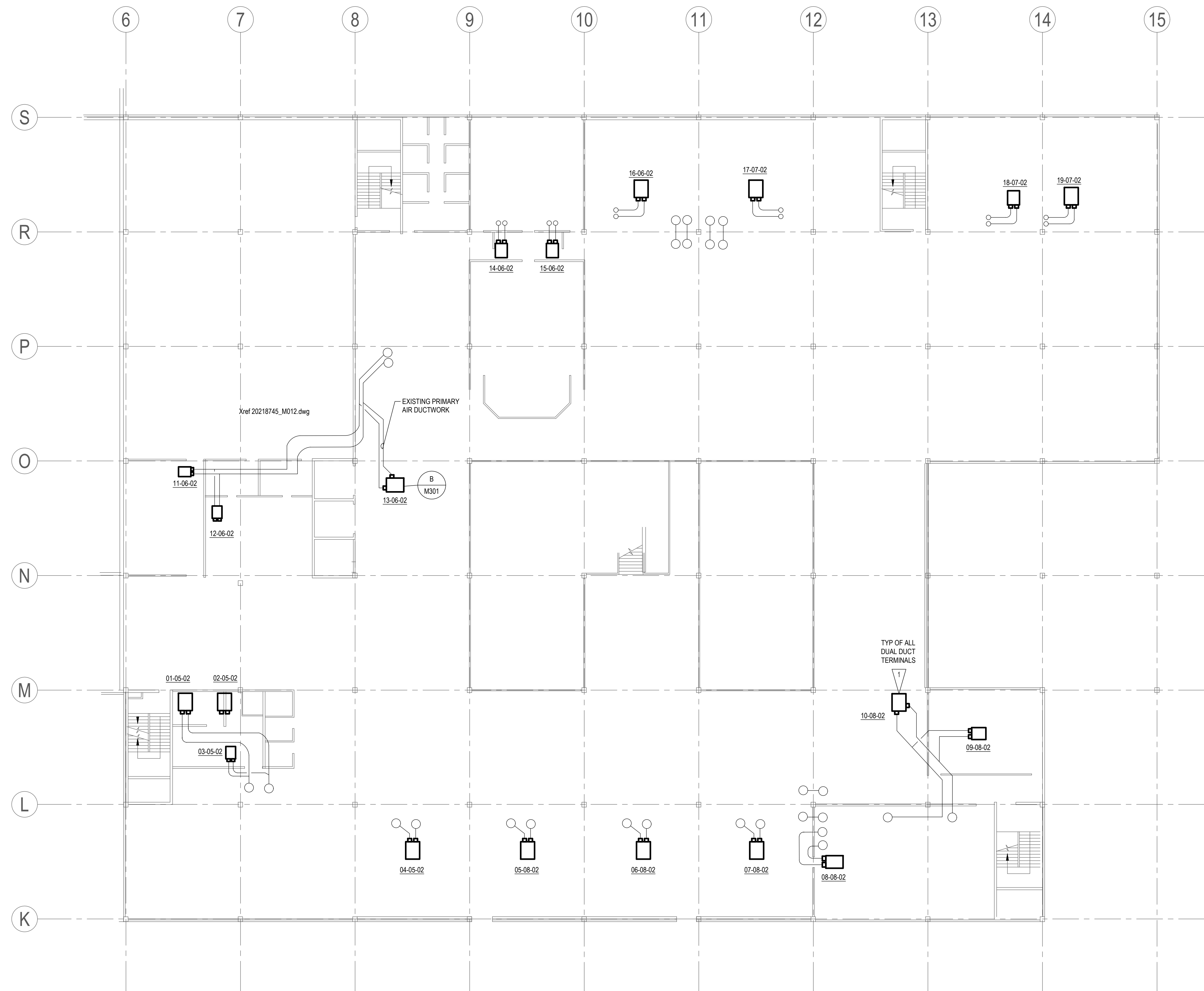
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LEM	KMF	EJK	05/16/2022
File Name	Project No.	Drawing No.	
20218745_M101	20218745	M101	

C.A. NO. 842 05/16/2022 EXPIRES 30/JUNE/2022

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

FLAG NOTES

EXISTING DUAL DUCT TERMINAL TO BE REPLACED. VERIFY EXISTING UNIT EXACT LOCATION AND ORIENTATION TO COORDINATE UNIT REPLACEMENT CONFIGURATION. ASSOCIATED UNIT THERMOSTAT TO BE REPLACED AND WIRED IN EXISTING LOCATION. UNIT TO BE CONNECTED AND INTEGRATED INTO THE EXISTING TRANE BUILDING AUTOMATION SYSTEM. REFER INSTALLATION DETAIL B301.

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SECOND FLOOR PLAN - HVAC
OCCC MAIN BUILDING AHU REPLACEMENT
OKLAHOMA CITY OKLAHOMA



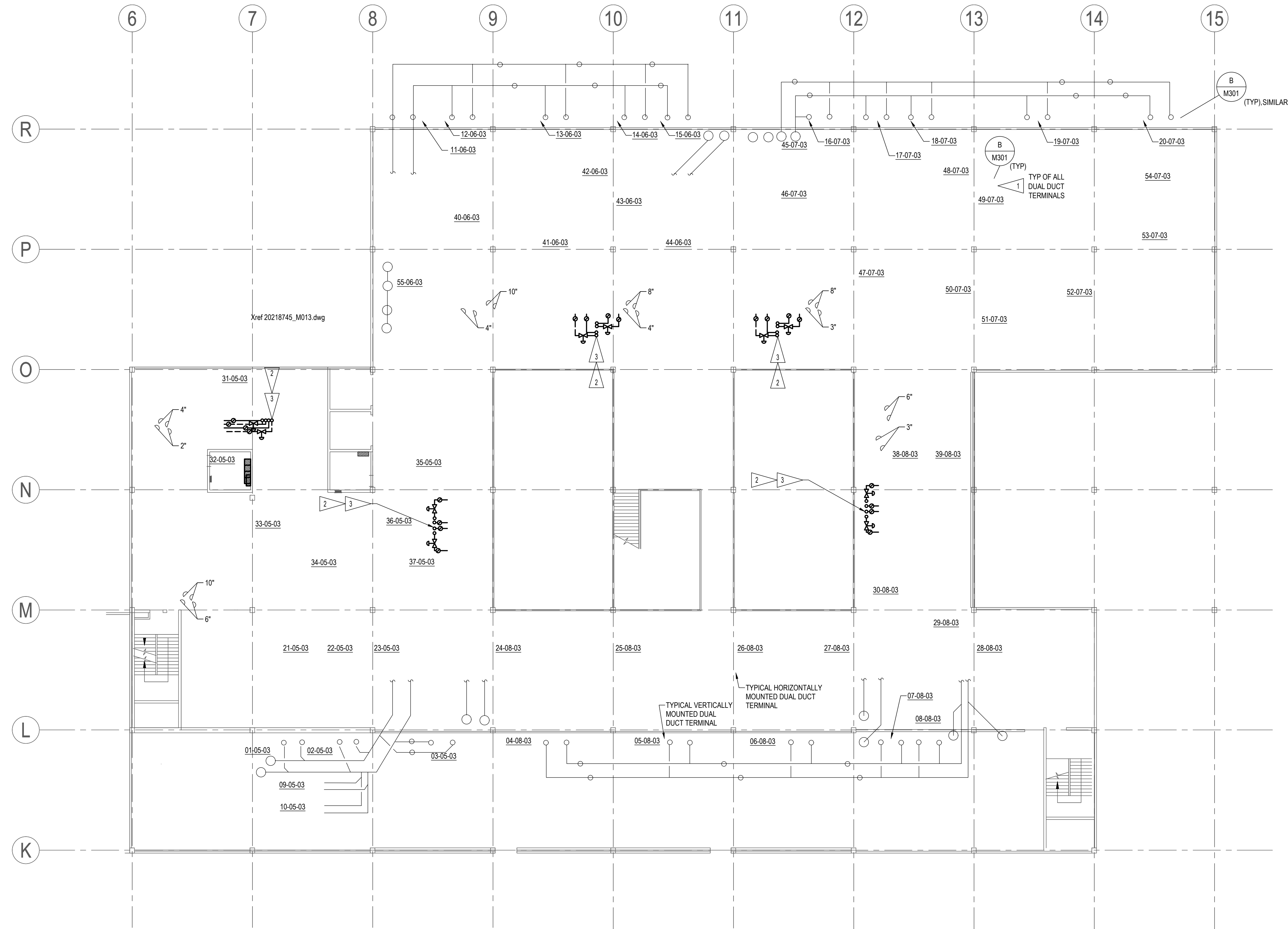
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Designed	File Name																
LEM	20218745_M102																
Drawn	Project No.																
KMF	20218745																
Checked	Drawing No.																
EJK	M102																
Date																	
05/16/2022																	

C.A. NO. 842 05/16/2022 EXPIRES 30/JUNE/2022

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

FLAG NOTES

- 1 EXISTING DUAL DUCT TERMINAL TO BE REPLACED. VERIFY EXISTING UNIT EXACT LOCATION AND ORIENTATION TO COORDINATE UNIT REPLACEMENT CONFIGURATION. ASSOCIATED UNIT THERMOSTAT TO BE REPLACED AND WIRED IN EXISTING LOCATION. UNIT TO BE CONNECTED AND INTEGRATED INTO THE EXISTING TRANE BUILDING AUTOMATION SYSTEM. REFER INSTALLATION DETAIL B301.
- 2 EXISTING CWRNHW UP TO AHU ON ROOF. VERIFY EXACT LOCATION AND COORDINATE WITH PIPING CONNECTION LOCATION OF AHU ON ROOF. REPLACE EXISTING SHUTOFF VALVE TO MATCH LINE SIZE. VERIFY EXACT SIZE.
- 3 EXISTING CWRNHW UP TO AHU ON ROOF. VERIFY EXACT LOCATION AND COORDINATE WITH PIPING CONNECTION LOCATION OF AHU ON ROOF. REPLACE EXISTING 2-WAY CONTROL VALVE AND SHUTOFF VALVE TO MATCH LINE SIZE. VERIFY EXACT SIZE.

No	Revisions	Date

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, SHIP and other appropriate drawings or as site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

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**THIRD FLOOR PLAN
HVAC**

**OCCC
MAIN BUILDING
AHU REPLACEMENT**

OKLAHOMA CITY OKLAHOMA

ALVINE Engineering

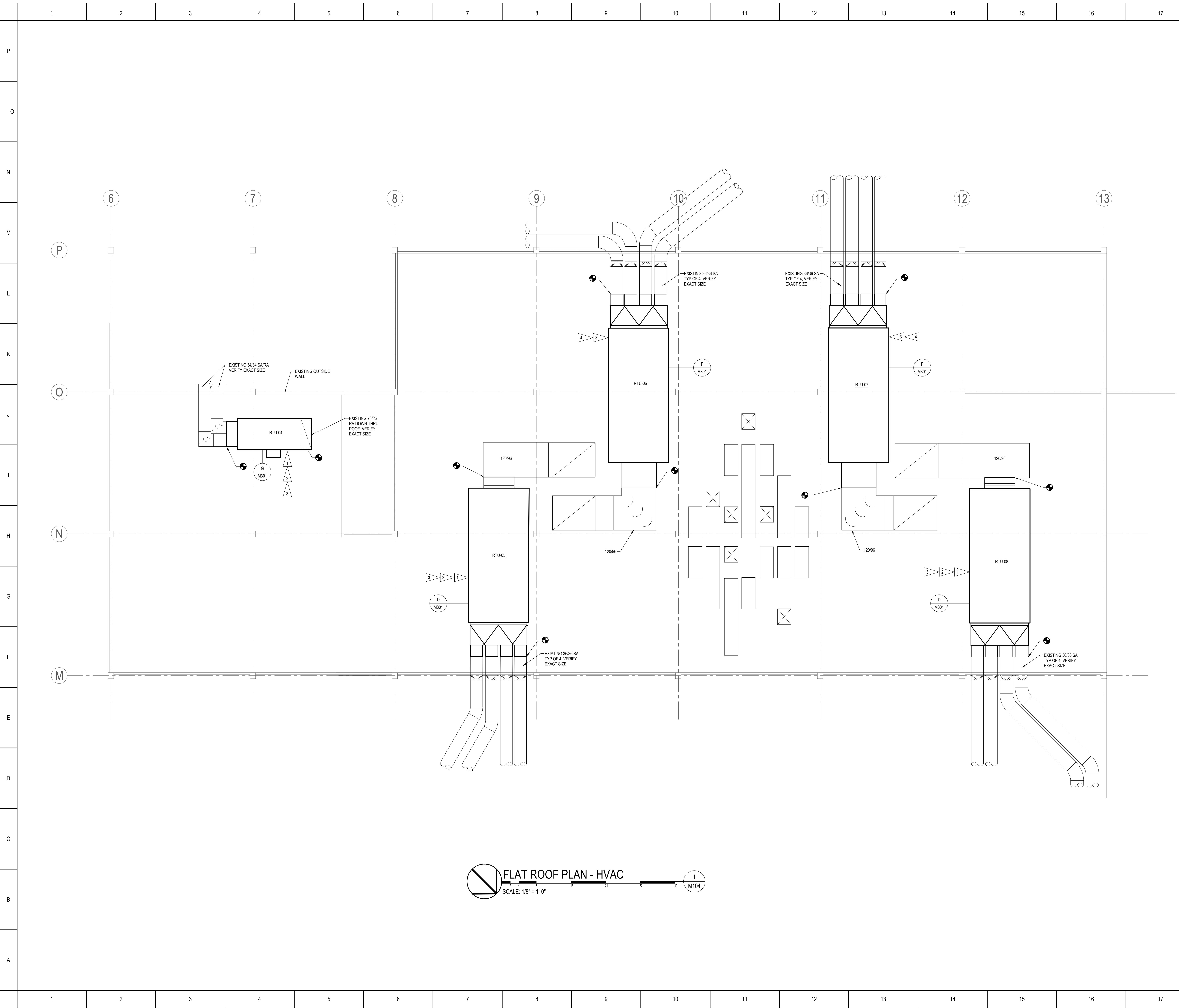
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Designed	Drawn	Checked	Date
LEM	KMF	EJK	05/16/2022

Project No. 20218745
Drawing No. **M103**

C.A. NO. 842 05/16/2022 EXPIRES 30/JUNE/2022

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- FLAG NOTES**
- 1 REPLACE EXISTING ROOF MOUNTED AHU ON NEW 18" TALL ROOF CURB. REFER DETAIL DM301.
 - 2 EXISTING ROOF CURB AT AIR HANDLING UNIT TO BE REPLACED. CONTRACTOR PROVIDE NEW ROOF CURB FLASHINGS AND COORDINATE NEW ROOF CURB INSTALLATION WITH EXISTING ROOFING CONTRACTOR NO EXCEPTIONS OR SUBSTITUTES. OKLAHOMA ROOFING, AND SHEET METAL. 1708 S. LOWRY AVENUE. OKLAHOMA CITY, OK. 73129. 405 670 1429.
 - 3 INSTALL NEW ROOFTOP AHU INDICATED RECONNECT HWS/ HWR, CWS/ CWR PER DETAILS C AND E ON SHEET M301. VERIFY AND COORDINATE EXACT LOCATION. PROVIDE NEW PIPING UNION CONNECTION ABOVE ROOF.
 - 4 REPLACE EXISTING ROOF MOUNTED AHU ON EXISTING ELEVATED STEEL PLATFORM. REFER DETAIL FM301.

No	Revisions	Date

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FLAT ROOF PLAN - HVAC

OCCC MAIN BUILDING AHU REPLACEMENT

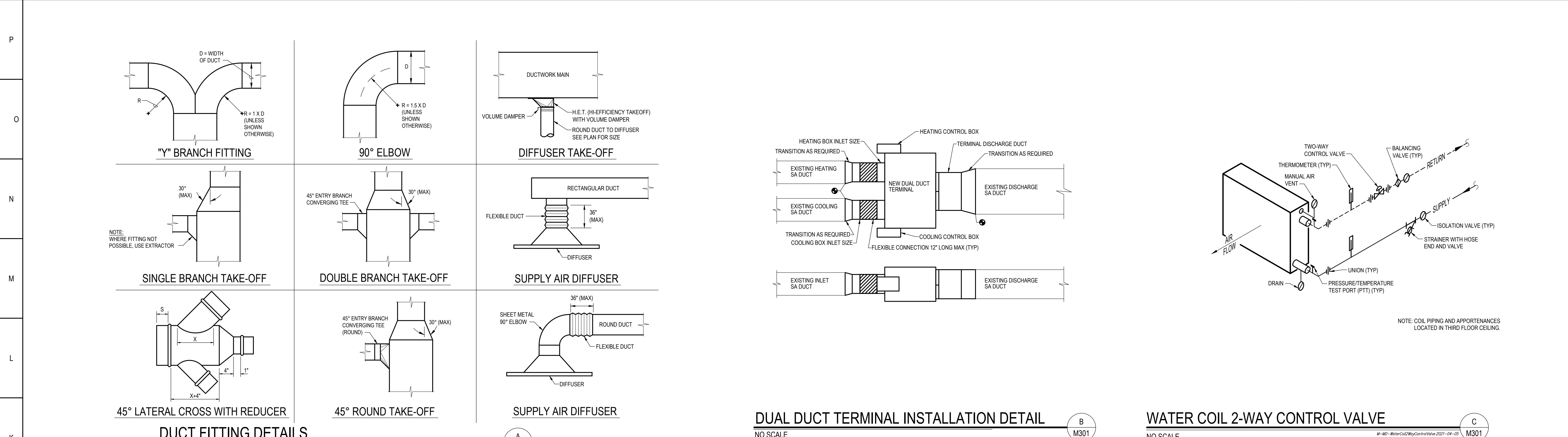
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Designed	File Name
LEM	20218745_M104
Drawn	Project No.
KMF	20218745
Checked	Drawing No.
EJK	M104
Date	05/16/2022

C.A. NO. 842 05/16/2022 EXPIRES 30/JUNE/2022



DUCT FITTING DETAILS

NO SCALE

M-40-DuctFittingDetails2020-09-07
A
M301

DUAL DUCT TERMINAL INSTALLATION DETAIL

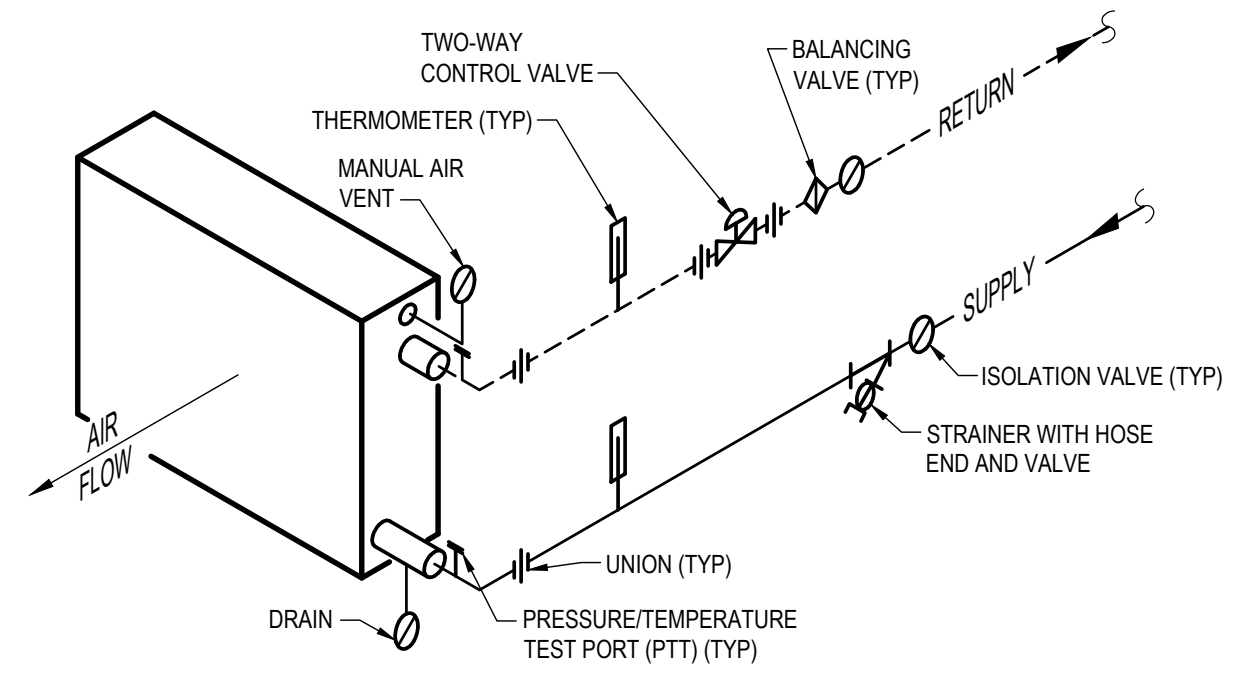
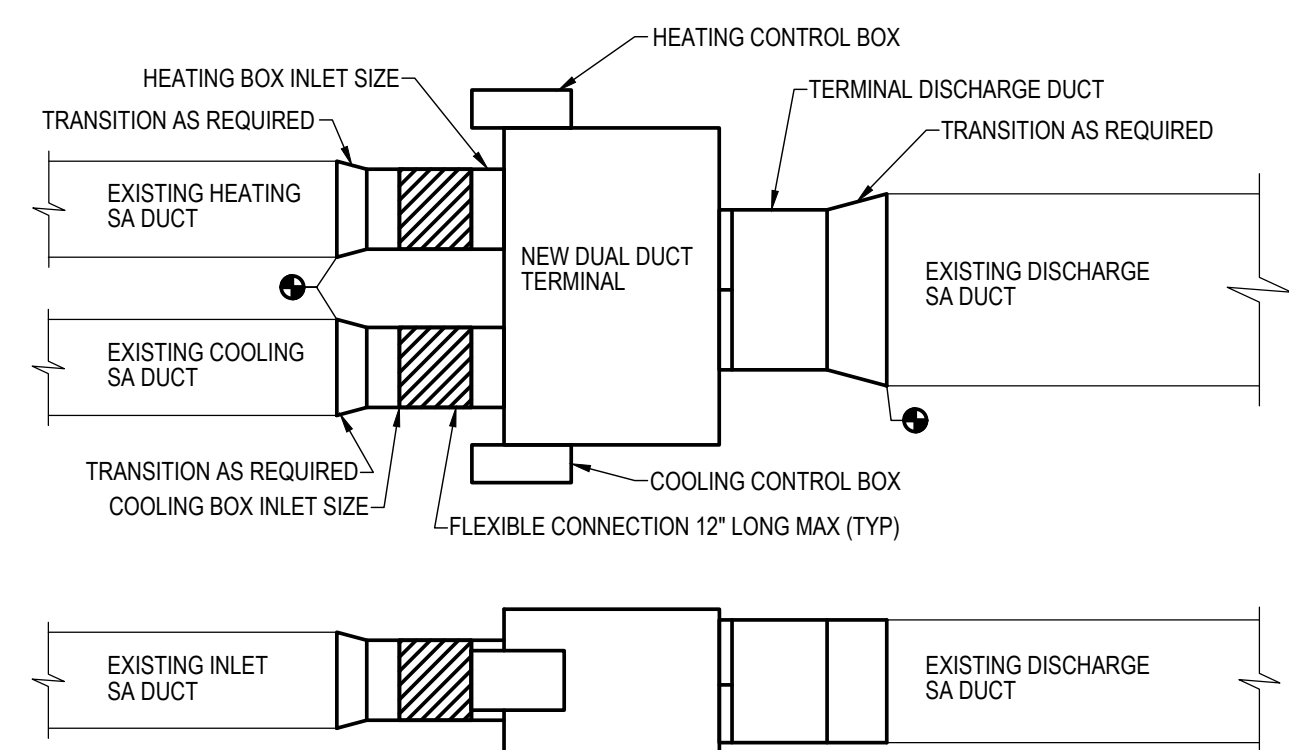
NO SCALE

B
M301

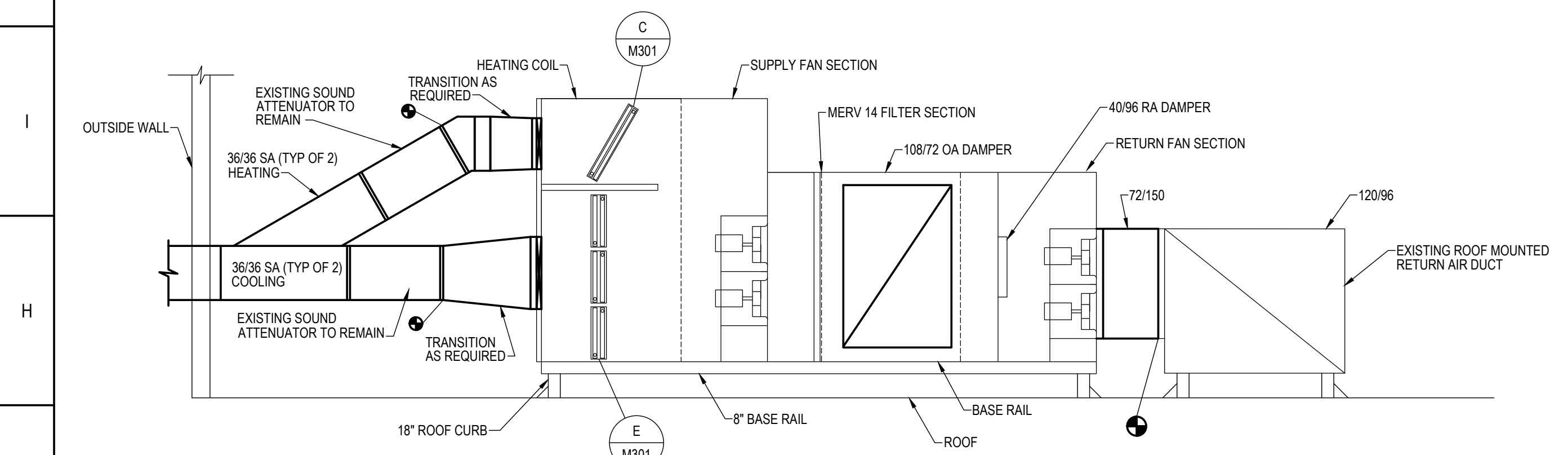
WATER COIL 2-WAY CONTROL VALVE

NO SCALE

M-40-WaterCoil2WayControlValve2021-04-05
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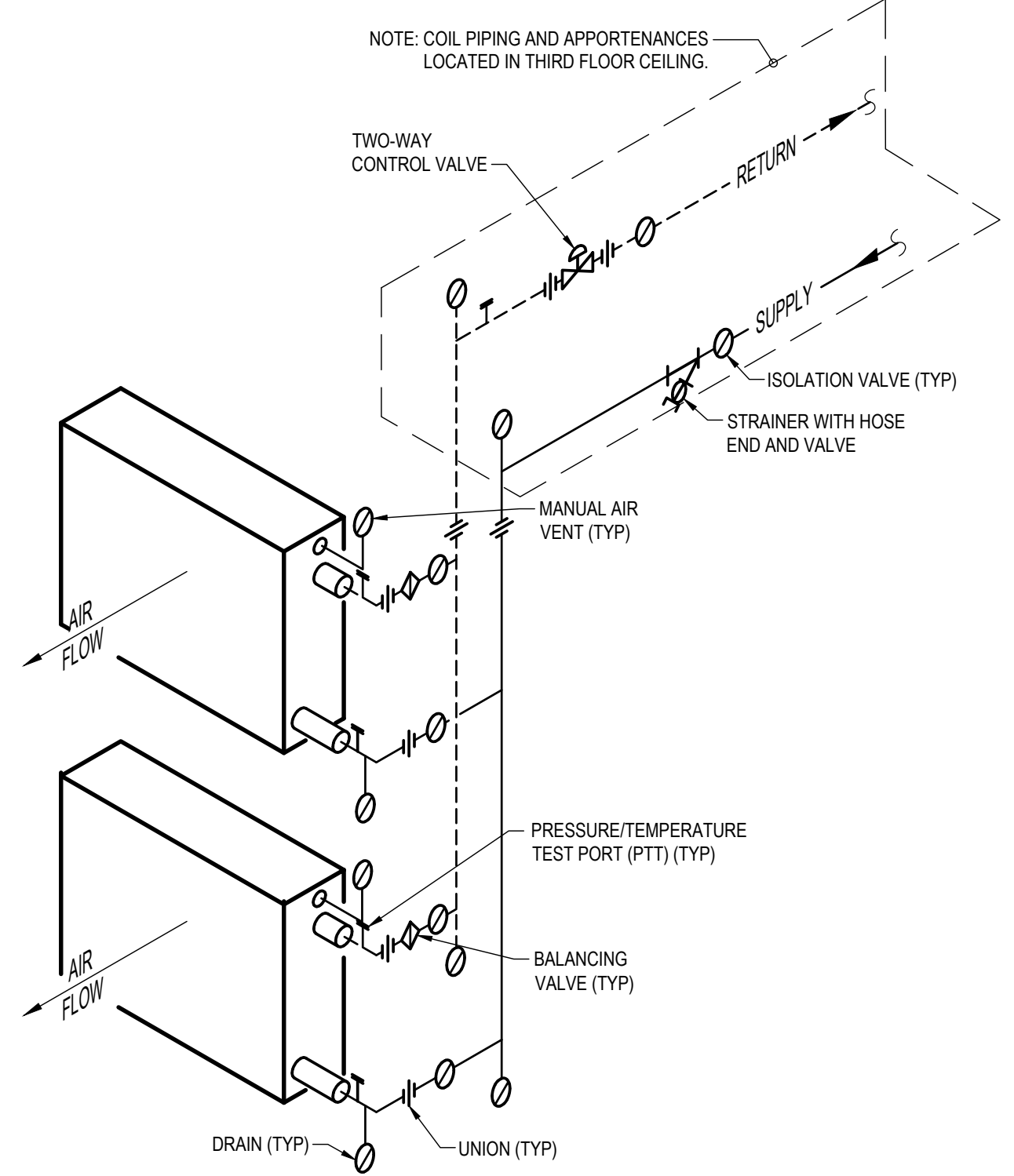
NOTE: COIL PIPING AND APPURTENANCES LOCATED IN THIRD FLOOR CEILING.



ELEVATION AT ROOFTOP AHU (ROOF CURB MOUNT)

NO SCALE

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M301

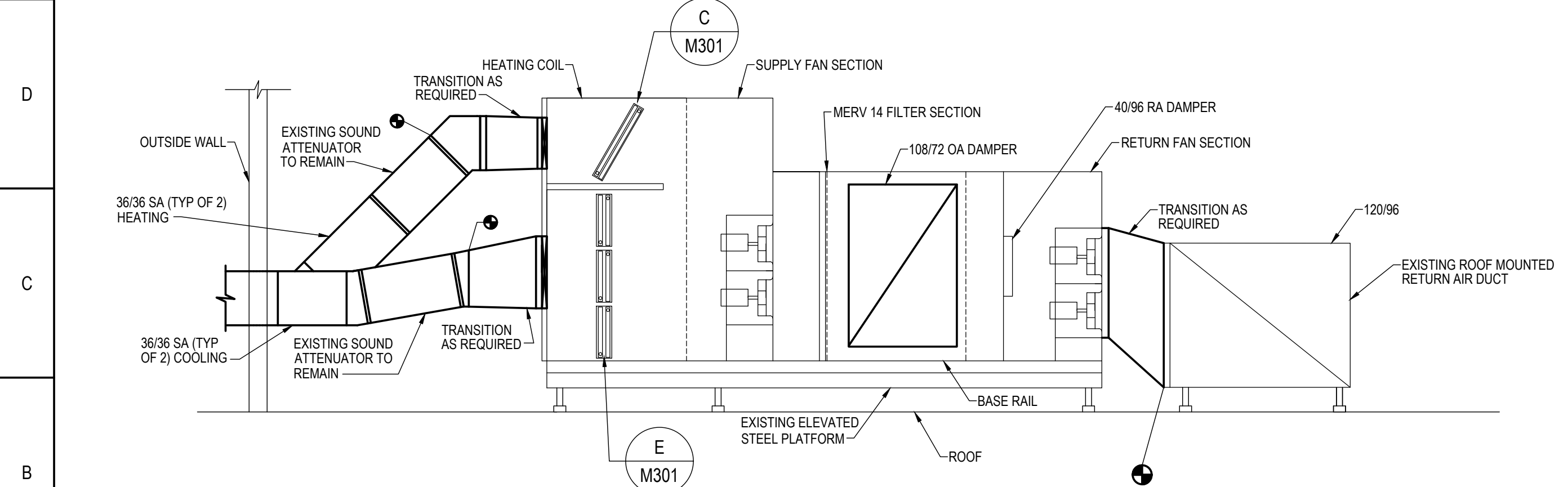


NOTE: COIL PIPING AND APPURTENANCES LOCATED IN THIRD FLOOR CEILING.

WATER COIL 2-WAY CONTROL VALVE MULTIPLE COILS

NO SCALE

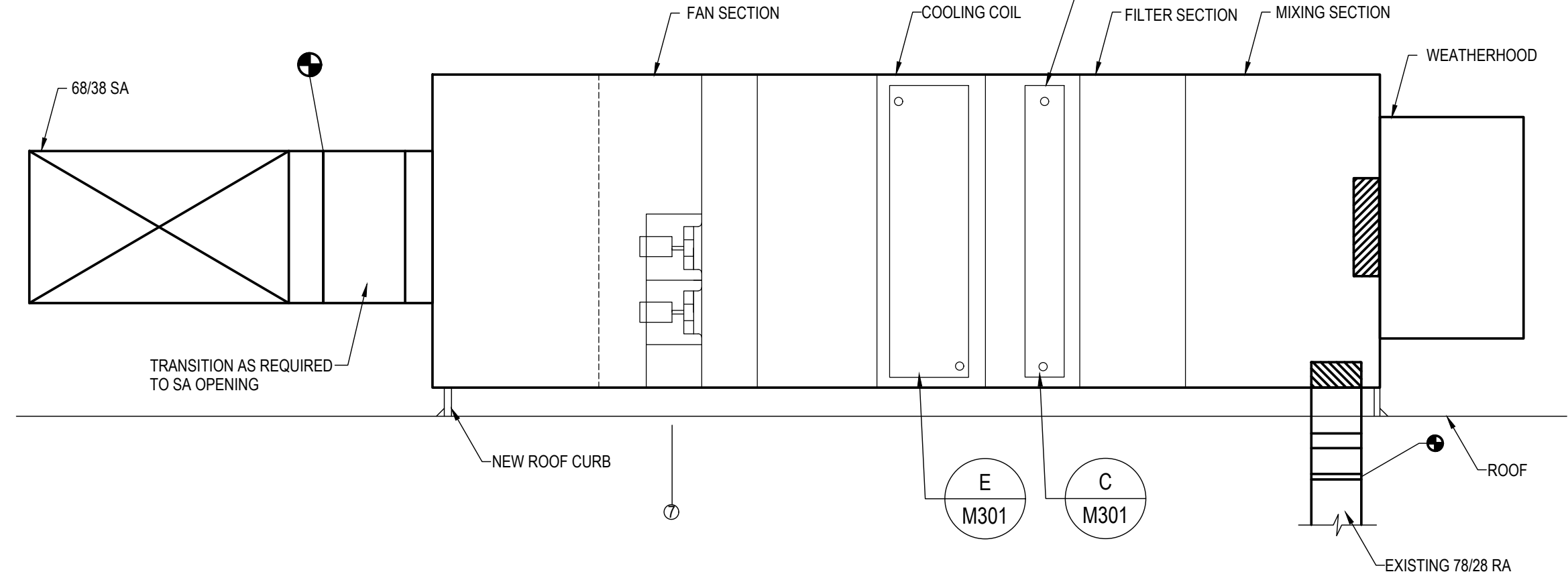
M-40-WaterCoil2WayControlValveMultipleCoils2021-04-05
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ELEVATION AT ROOFTOP AHU (ELEVATED MOUNT)

NO SCALE

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M301



ELEVATION AT ROOFTOP AHU (SINGLE ZONE)

NO SCALE

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M301

FLAG NOTES

No	Revisions	Date

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MECHANICAL DETAILS

OCCC MAIN BUILDING AHU REPLACEMENT
OKLAHOMA CITY OKLAHOMA



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Oklahoma City: 1527 Broadway, Suite 101, Oklahoma City, Oklahoma 73104, Phone: (405) 763-3400
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LEM	20218745_M301
Drawn	Project No.
JJK	20218745
Checked	Drawing No.
EJK	M301
Date	05/16/2022

C.A. NO. 842 05/16/2022 EXPIRES 30/JUNE/2022

CUSTOM AIR HANDLING UNIT SCHEDULE						
MARK	SERVES	TYPE	RTU 04		RTU 05, 06, 07, 08	
			GYMNASIUM	MAIN BUILDING	ROOF	ROOF
GENERAL DATA	LOCATION		17800	50000	17800	50000
	TOTAL AIRFLOW (CFM)		17800	50000	17800	50000
	MAX OUTSIDE AIRFLOW (CFM)		2000	5000	2000	5000
	MIN OUTSIDE AIRFLOW (CFM)		151120/78	374 X 174 X 185		
	OVERALL SIZE (LxWxH) (IN)		6916	27500		
	MAX WT (LBS)					
	CONFIGURATION		HORIZ DRAW THRU	HORIZ BLOW THRU		
	MARK		RTU 04	RTU 05, 06, 07, 08		
	FAN TYPE/QTY		PLENUM4	PLENUM6		
	CLASS		II	II		
SUPPLY FAN/ARRAY DATA	CFM		17800	50000		
	EXT S.P. (IN. W.C.)		1.70	3.00		
	TOTAL S.P. (IN. W.C.)		4.35	6.90		
	MIN DIAMETER (IN)		18	22		
	MAX FAN RPM		2261	2214		
	MAX FAN BHP (EACH)		4.84	12.63		
	REMARKS					
	HP (EACH)		5	15		
	RPM		1800	1800		
	TYPE		DD	DDP		
SUPPLY FAN/MOTOR DATA	CONTROL DEVICE		VFD	VFD		
	REMARKS					
	TOTAL CAPACITY (MBH)		486.00	1885.00		
	ENTERING AIR TEMP, DB (°F)		64	55		
	LEAVING AIR TEMP, DB (°F)		89	95		
	MAX FACE VELOCITY (FPM)		452	995		
	MAX APD (IN. W.C.)		0.05	0.57		
	ENTERING WATER TEMP (°F)		180	160		
	LEAVING WATER TEMP (°F)		156	130		
	GLYCOL TYPE AND %		-	-		
HEATING DATA	WATER FLOW RATE (GPM)		42.0	147.0		
	WATER PRESSURE DROP (FT)		3.8	7.1		
	COIL ROWS AND FINS PER FT.		1 - 80	2/10 FIN		
	QTY, DIM (LxW) (IN)		1, 54X105	1, 54X134		
	REMARKS					
	TOTAL CAPACITY (MBH)		632.00	2324.20		
	SENSIBLE CAPACITY (MBH)		481.60	1473.00		
	ENTERING AIR TEMP, DB/F WB (°F)		77.0/64.4	76/65		
	LEAVING AIR TEMP, DB (°F)/WB (°F)		52.4/52.1	49/48		
	MAX FACE VELOCITY (FPM)		440	490		
COOLING DATA	MAX APD (IN. W.C.)		0.53	0.90		
	ENTERING WATER TEMP (°F)		45	44		
	LEAVING WATER TEMP (°F)		54	54		
	GLYCOL TYPE AND %		-	-		
	WATER FLOW RATE (GPM)		152.0	482.0		
	WATER PRESSURE DROP (FT)		8.1	20.5		
	COIL ROWS AND FINS PER FT.		6/108	8/10 FIN		
	QTY, DIM (LxW) (IN)		1, 55X105	3, 36X136		
	REMARKS					
	MARK		PRE-04	PRE-05, 06, 07, 08		
PREFILTER DATA	TYPE		CARTRIDGE	CARTRIDGE		
	THICKNESS (IN)		2	2		
	MAX FACE VELOCITY (FPM)		440	431		
	MAX INITIAL APD (IN. W.C.)		0.632	0.632		
	MERV RATING		8	8		
	QTY		10	34		
	SIZE (IN)		(2) 24X12 - (8) 24X24	(4) 12X24, (8) 24X12, (24) 24X24		
	REMARKS					
	MARK		PRIMARY-04	PRIMARY-05, 06, 07, 08		
	PRIMARY FILTER DATA	TYPE		CARTRIDGE	CARTRIDGE	
THICKNESS (IN)			4	4		
MAX FACE VELOCITY (FPM)			484	431		
MAX INITIAL APD (IN. W.C.)			0.8	0.706		
MERV RATING			15	13		
QTY			30	24		
SIZE (IN)			(10) 16X20, (20) 20X20	(4) 12X24, (8) 24X12, (24) 24X24		
REMARKS						
FAN TYPE/QTY				PLENUM2		
RETURN FAN/ARRAY DATA		CLASS		III		
	AIRFLOW (EACH) (CFM)		30000			
	EXT S.P. (IN. W.C.)		2.5			
	TOTAL S.P. (IN. W.C.)		1.0			
	MIN DIAMETER (IN)		27			
	MAX FAN RPM		1528			
	MAX FAN BHP (EACH)		6.85			
	REMARKS					
	HP (EACH)		7.5			
	RPM		1200			
RETURN FAN/MOTOR DATA	TYPE		TEFC PREMIUM			
	CONTROL DEVICE		VFD			
	REMARKS					
	MANUFACTURER		TRANE			
	MODEL NUMBER		CSAA 043	CUSTOM		
	REFERENCE SPECIFICATION		23 7323	23 7323		
	REMARKS					

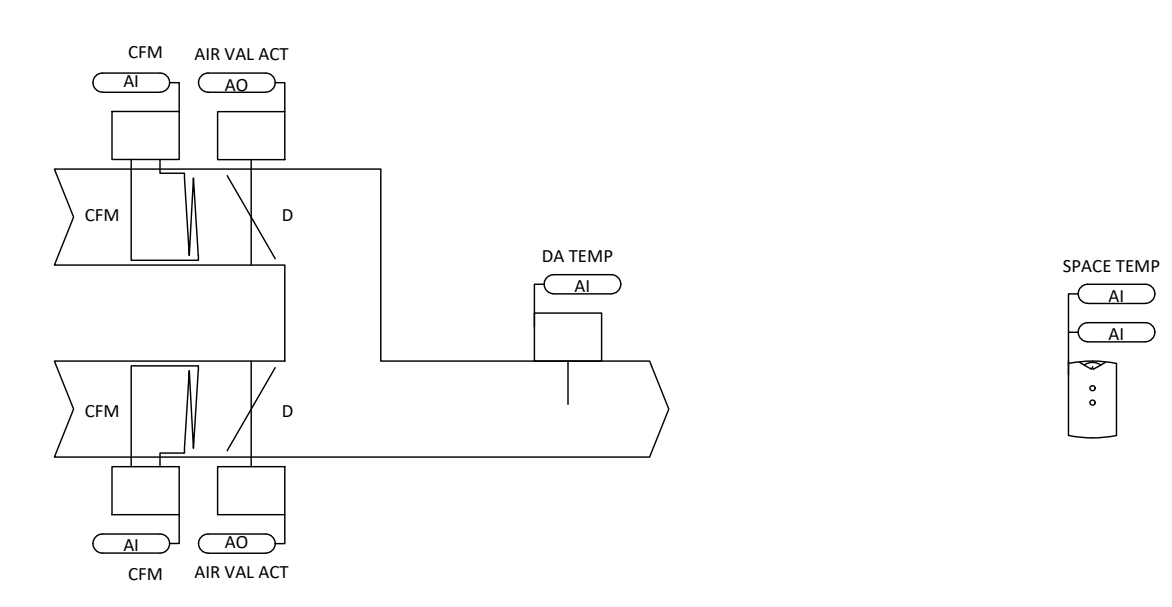
REMARKS:
 1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E104 FOR ELECTRICAL DATA.
 2. PROVIDE SMOKE DETECTOR IN SUPPLY/RETURN DUCTWORK TO SHUT DOWN UNIT UPON DETECTION OF SMOKE. UNIT SHUTDOWN SHALL BE OVER-RIDDEN UPON INITIATION OF SMOKE CONTROL SEQUENCE. REFER SEQUENCE OF OPERATION.

DUAL DUCT AIR TERMINAL UNIT SCHEDULE																		
MARK	SERVES	TYPE	COLD SIDE					HOT SIDE					DIMENSIONS (LxWxH) (IN)	WEIGHT (LBS)	MANUFACTURER	MODEL	REFERENCE SPECIFICATION	REMARKS
			CFM		NC @ MIN. S.P.	BOX INLET DIAMETER (IN)	INLET DUCT SIZE (IN)	CFM		NC @ MIN. S.P.	BOX INLET DIAMETER (IN)	INLET DUCT SIZE (IN)						
01-05-01	FIRST FLR	DUAL DUCT	3200	1600		16	16	2560	770		16	16	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
02-05-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
03-05-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
04-08-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
05-08-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
06-08-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
07-08-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
08-08-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
09-08-01	FIRST FLR	DUAL DUCT	2200	1440		12	12	1760	530		12	12	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
10-05-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
11-05-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
12-05-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
13-05-01	FIRST FLR	DUAL DUCT	3630	1815		16	16	2905	870		16	16	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
14-08-01	FIRST FLR	DUAL DUCT	2440	1220		14	14	1950	585		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
15-08-01	FIRST FLR	DUAL DUCT	1900	950		12	12	1520	455		12	12	24 x 40 x 22	60	TRANE	VDOF	23 36 00	
16-08-01	FIRST FLR	DUAL DUCT	1800	900		12	12	1440	430		12	12	24 x 40 x 22	60	TRANE	VDOF	23 36 00	
17-05-01	FIRST FLR	DUAL DUCT	3200	1600		16	16	2560	770		16	16	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
18-05-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
19-05-01	FIRST FLR	DUAL DUCT	2160	1080		14	14	1730	520		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
20-08-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
21-06-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
22-07-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
23-07-01	FIRST FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
24-07-01	FIRST FLR	DUAL DUCT	2540	1270		14	14	2030	610		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
25-07-01	FIRST FLR	DUAL DUCT	2400	1200		14	14	1920	575		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
26-07-01	FIRST FLR	DUAL DUCT	2400	1200		14	14	1920	575		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
27-07-01	FIRST FLR	DUAL DUCT	1630	815		12	12	1305	390		12	12	24 x 40 x 22	60	TRANE	VDOF	23 36 00	
28-06-01	FIRST FLR	DUAL DUCT	2400	1200		14	14	1920	575		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
29-06-01	FIRST FLR	DUAL DUCT	2500	1250		14	14	2000	600		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
30-06-01	FIRST FLR	DUAL DUCT	885	345		8	8	560	165		8	8	22 X 28 X 16	55	TRANE	VDOF	23 36 00	
31-06-01	FIRST FLR	DUAL DUCT	1160	580		10	10	930	280		10	10	22 X 28 X 16	61	TRANE	VDOF	23 36 00	
32-06-01	FIRST FLR	DUAL DUCT	1865	933		12	12	1490	445		12	12	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
33-06-01	FIRST FLR	DUAL DUCT	1865	933		12	12	1490	445		12	12	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
34-06-01	FIRST FLR	DUAL DUCT	1865	933		12	12	1490	445		12	12	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
35-06-01	FIRST FLR	DUAL DUCT	1160	580		10	10	930	280		10	10	22 X 28 X 16	61	TRANE	VDOF	23 36 00	
36-07-01	FIRST FLR	DUAL DUCT	2920	1460		14	14	2335	700		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
37-07-01	FIRST FLR	DUAL DUCT	2840	1420		14	14	2270	680		14	14	24 x 40 x 22	81	TRANE	VDOF	23 36 00	
38-07-01	FIRST FLR	DUAL DUCT	1320	660		10	10	1055	315		10	10	22 X 28 X 16	61	TRANE	VDOF	23 36 00	
39-07-01	FIRST FLR	DUAL DUCT	1440	720		12	12	1150	345		12	12	24 x 40 x 22	60	TRANE	VDOF	23 36 00	
01-05-02	SECOND FLR	DUAL DUCT	2880	1440		14	14	2305	690		14	14						

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FLAG NOTES

DOUBLE DUCT UNITS FIRST FLOOR 1-39
SECOND FLOOR 1-19
THIRD FLOOR 1-55



DOUBLE DUCT 1 ~ 113 TRANE TRACER S210 FLOW - SYSTEM POINTS LIST																
CONTROLLER: UC210 VAV	POINT TYPE						ALARMS									
SYSTEM POINT DESCRIPTION	GRAPHIC	HARDWARE INPUT	HARDWARE OUTPUT	SOFTWARE POINT	HARDWARE INTERLOCK	WIRELESS	NETWORK	DEFAULT VALUE	HIGH ANALOG LIMIT	LOW ANALOG LIMIT	BINARY	LATCH DIAGNOSTIC	SENSOR FAIL	COMMUNICATION FAIL	DIAGNOSTICS	NOTES
COOLING AIRFLOW LOCAL	X	AI											X		SENSOR FAILURE	
HEATING AIRFLOW LOCAL	X	AI											X		SENSOR FAILURE	
DISCHARGE AIR TEMPERATURE LOCAL	X	AI											X		SENSOR FAILURE	
SPACE TEMPERATURE LOCAL	X	AI							X	X			X		SENSOR FAILURE	
SPACE TEMPERATURE SETPOINT LOCAL	X	AI											X		SENSOR FAILURE	
COOLING DAMPER COMMAND	X		AO													
HEATING DAMPER COMMAND	X		AO													
MINIMUM COOLING AIRFLOW SETPOINT				X												NOTE 1
MAXIMUM COOLING AIRFLOW SETPOINT				X												NOTE 1
MINIMUM HEATING AIRFLOW SETPOINT				X												NOTE 1
MAXIMUM HEATING AIRFLOW SETPOINT				X												NOTE 1
BAS COMMUNICATION STATE	X							2 HRS					X		COMMUNICATION FAILURE	
CONTROLLER SPARE HARDWARE POINTS																
ANALOG INPUT(S)		5														
BINARY INPUT(S)		0														
ANALOG OUTPUT(S)			2													
BINARY OUTPUT(S)			0													
GENERAL NOTES																
1. SEE VAV SCHEDULE FOR VALUES																
2. OPTIONAL FEATURE																
3. DISPLAYED AT THE BAS USER INTERFACE IF PRESENT																

Sequence of Operation
Dual Duct VAV

Building Automation System Interface:
The Building Automation System (BAS) shall include a user-adjustable time-of-day schedule to define when the various areas of the facility are expected to be occupied versus unoccupied. Then, based on current zone conditions, the BAS determines the current system operating mode.

Occupied Heat/Cool
During the Occupied Mode, each VAV terminal unit varies the flow of conditioned air to maintain zone temperature at the occupied setpoint (cooling or heating). Control of the hot/cold air valves is determined locally by the VAV box controller. Meanwhile, the air-handling unit (AHU) modulates the supply fan and return fan (if equipped) to deliver the required airflow to the zones, positions the outdoor-air damper to bring in required amount of ventilation, modulates the central relief damper (or relief fan) to maintain building pressure at the desired setpoint, and modulates the chilled-water valve, modulates (or stages) the source of heat, and/or enables the outside economizer to discharge air at the desired setpoints.

Unoccupied Heat/Cool
During the Unoccupied Mode, each VAV terminal unit varies the flow of conditioned air to maintain zone temperature at the unoccupied setpoint (cooling or heating). Control of the hot/cold air valves is determined locally by the VAV box controller. Meanwhile, the AHU modulates the supply fan and return fan (if equipped) to deliver the required airflow to the zones, closes the outdoor-air damper, closes the central relief damper (or shuts off the central relief fan), and modulates the chilled-water valve or modulates (or stages) the source of heat to discharge air at the desired setpoints.

Morning Warm-up/Pre-cool
During the Morning Warm-up/Pre-cool Mode, each VAV terminal unit varies the flow of conditioned air to raise/lower the zone temperature to the occupied setpoint (heating or cooling), and then closes. Control of the hot/cold air valves is determined locally by the VAV box controller. Meanwhile, the AHU modulates the supply fan and return fan (if equipped) to deliver the required airflow to the zones, closes the outdoor-air damper, closes the central relief damper (or shuts off the central relief fan), and modulates the chilled-water valve or modulates (or stages) the source of heat to discharge air at the desired setpoints.

For the cold deck system, if the return air dew point temperature is higher than 55°F (adj) during Morning Pre-cool Mode, the discharge-air temperature setpoint will be reset every 10 minutes so that it is only 2°F (adj) below the current return air dew point temperature.

Optimized System-Level Control Sequences: The BAS shall perform the following optimized system-level control strategies:

Optimal Start
The BAS shall initiate Optimal Start mode such that the AHU is started and VAV boxes are enabled to allow the zone temperature to reach the occupied heating or cooling setpoint prior to scheduled occupancy. The system shall wait as long as possible before starting, so that the temperature in each zone reaches the occupied setpoint just in time for scheduled occupancy.

Optimal Stop
The BAS shall initiate Optimal Stop mode such that cooling, or heating is disabled so that the zone temperature does not drift beyond the occupied standby setpoint by the end of the scheduled occupancy period. The AHU supply fan shall continue operating, and ventilation control shall continue, through the end of the scheduled occupancy period.

No	Revisions	Date

DO NOT SCALE DRAWINGS. VERIFY ALL DIMENSIONS and clearances from ARCHITECTURAL, STRUCTURAL, shop and other appropriate drawings or at site. Lay out and coordinate all work prior to installation to provide clearances required for operation, maintenance, and codes. Verify non-interference with other work. DO NOT FABRICATE PRIOR TO VERIFICATION OF CLEARANCE FOR ALL TRADES. READ SPECIFICATIONS.

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MECHANICAL SCHEDULES

**OCCC
MAIN BUILDING
AHU REPLACEMENT**

OKLAHOMA CITY OKLAHOMA

Omaha: 1701 Cass Street, Omaha, Nebraska 68102, Phone: (402) 246-7007
 Lincoln: 1800 O Street, Suite 104, Lincoln, Nebraska 68508, Phone: (402) 477-8181
 Oklahoma City: 13422 Broadway Boulevard, Suite 101, Oklahoma City, Oklahoma 73114, Phone: (405) 718-3489
 Des Moines: 405 East Court Ave, Suite 130, Des Moines, Iowa 50319, Phone: (515) 243-0048

Designed	File Name
LEM	20216745_M402
Drawn	Project No.
JK	20216745
Checked	Drawing No.
EJK	M402
Date	
05/16/2022	

C.A. NO. 842 05/16/2022 EXPIRES 30 JUNE 2022



ACADEMIC CALENDAR 2021/2022

	Classes Begin		Classes End		Holiday		Commencement: May 13-14		Classes do not meet
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	Deans' Council		New Faculty		Welcome Week		Institution is Closed		Library only open
--	----------------	--	-------------	--	--------------	--	-----------------------	--	-------------------

June 2021						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

July 2021						
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August 2021						
S	M	T	W	T	F	S
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29	30	31				

September 2021						
S	M	T	W	T	F	S
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26	27	28	29	30		

October 2021						
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17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

November 2021						
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28	29	30				

December 2021						
S	M	T	W	T	F	S
			1	2	3	4
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12	13	14	15	16	17	18
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26	27	28	29	30	31	

January 2022						
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30	31					

February 2022						
S	M	T	W	T	F	S
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27	28					

March 2022						
S	M	T	W	T	F	S
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27	28	29	30	31		

April 2022						
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24	25	26	27	28	29	30

May 2022						
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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Summer: June 7-July 30

Fall Semester: Aug 16-Dec 18

Spring: Jan 18-May 14

Aug Intersession: Aug 2-13

Early Fall: Aug 16-Oct 9

Early Spring: Jan 10-Mar 5

January Intersession: Jan 3-Jan 14

Late-Fall: Oct 18-Dec 18

Late-Spring: Mar 21-May 14

May Intersession: May 16-May 27

August and January intersessions fall during Welcome Week.

2022-2023 Academic Calendar – All Dates

2022	
January 3	First day of January Intersession
Prior to Third Class Period	Last day to withdraw from January Intersession with a refund
January 10	First day of Spring 16 weeks and early 8 weeks
January 11	End of late registration for Spring early 8 weeks
January 12	Last day to withdraw from January intersession with W on transcript. No refund
January 14	Last day of January intersession. Last day to add a class for 16 weeks
January 16	Last day to withdraw from Spring early 8 weeks with refund
January 17	Martin Luther King Jr.'s birthday observed – College Closed
January 23	Last day to withdraw from Spring 16 weeks with a refund
February 5	First day of Spring Fast Track I
February 13	Last day to withdraw from Spring Fast Track I with a refund
February 20	Last day to withdraw from Spring early 8 weeks with W on transcript. No refund.
February 23	Last day to withdraw from Spring Fast Track I with W on transcript. No refund
March 5	Last day of Spring early 8 weeks and Fast Track I courses
March 7-12	Work ahead week for Spring 16 weeks courses
March 14-18	Spring Break – College Closed
March 21	Beginning of early registration for returning students for Summer and Fall 2022 semesters
March 21	First day of late 8 weeks courses
March 22	Last day to register for Spring late 8-week courses
March 27	Last day to withdraw from Spring late 8 weeks with refund
March 28	Beginning of open registration for Summer and Fall 2022
April 16	Spring Fast track II begins
April 17	Easter Sunday – College Closed
April 17	Last day to drop Spring 16 weeks with a W on transcript. No Refund
April 24	Last day to withdraw from Spring Fast Track II with a refund
May 1	Last day to withdraw from Spring late 8 weeks with W on transcript. No refund
May 4	Last day to withdraw from Spring Fast Track II with a W on transcript. No refund
May 13-14	Commencement
May 14	Last day of 16 weeks, late 8 weeks, and Fast Track II for Spring
May 16	Summer intersession begins
Prior to Third Class Period	Last day to withdraw from Summer intersession with no charge or refund
May 25	Last day to withdraw from Summer intersession with a W on transcript. No Refund
May 27	Summer intersession ends
May 30	Memorial Day – College Closed
May 31	First day of Summer and early 4 weeks

January 20, 2022

lr

June 1	Last day to register for Summer courses
June 5	Last day to withdraw from Summer 8 weeks and early 4 weeks with a refund or no charge
June 19	Last day to withdraw from Summer early 4 weeks with a W on transcript
June 20	Juneteenth Observed – College Closed
June 24	Last day of Summer early 4 weeks
June 27	Beginning of Summer late 4 weeks
June 28	Last day to add a class for Summer late 4 weeks
July 3	Last day to withdraw from Summer late 4 weeks with a refund or no charge
July 4	Fourth of July – College Closed
July 10	Last day to withdraw from summer 8 week with a W on transcript. No refund
July 17	Last day to withdraw from Summer late 4 weeks with a W on transcript. No refund
July 22	Last day of Summer 8 weeks and late 4 weeks
July 25	Fall 2022 Intersession begins
Prior to Third Class Period – July 27	Last day to drop Fall 22 Intersession with a refund or no charge
August 3	Last day to drop Fall Intersession with a W on transcript. No refund
August 5	Last day of Fall Intersession
August 15	First day of Fall 16 weeks and early 8-week courses
August 16	Last day to add a class for Fall 8 week
August 19	Last day to add a class for Fall 16 weeks
August 21	Last day to withdraw from Fall early 8 weeks with a refund
August 28	Last day to withdraw from Fall 16 weeks with a refund or no charge
September 5	Labor Day – College Closed
September 6	Fall Fast Track I begin
September 11	Last day to withdraw from Fall Fast Track I with a refund or no charge
September 25	Last day to withdraw from Fall early 8 weeks with W on transcript. No refund
September 28	Last day to drop Fall Fast Track I with a W on transcript. No refund
October 3	Beginning of early registration for returning students for Spring 2023
October 8	Last day of class for Fall early 8 weeks and Fast Track I
October 10	Beginning of open registration for Spring 2023
October 10 – 14	Work ahead week for 16 week – Fall break – No Classes
October 17	First day of Fall 22 late 8 weeks
October 18	Last day to enroll for Fall 22 late 8 weeks courses
October 23	Last day to withdraw from late 8 week with a refund or no charge
November 7	First day of Fast Track II
November 13	Last day to withdraw from Fall 16 weeks with a W on transcript. No refund
November 13	Last day to withdraw from Fall Fast Track II with a refund or no charge
November 23-27	Thanksgiving Break – College Closed
December 4	Last day to drop Fall late 8 weeks with W on transcript. No Refund
December 7	Last day to drop Fall Fast Track II with a W on transcript. No Refund

January 20, 2022

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December 17	Last day of Fall 16 weeks, late 8 weeks, and Fast Track II courses
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2023	
January 2	First day of January Intersession
Prior to Third Class Period-January 4	Last day to withdraw from January intersession with a refund
January 4	Last day to drop Spring 23 Intersession with a refund or no charge
January 11	Last day to withdraw from Spring intersession with a W on transcript. No Refund
January 13	Last day of January intersession
January 16	Martin Luther King Jr.'s birthday observed (College Closed)
January 17	First day of Spring 16 week and early 8 weeks
January 18	Last day to register for Spring 23 early 8 weeks
January 20	Last day to register for Spring 23 16 weeks
January 23	Last day to withdraw from Spring 8 weeks with a refund or no charge
January 29	Last day to withdraw from Spring 16 weeks with a refund or no charge
February 6	First day of Spring Fast Track I
February 12	Last day to withdraw from Spring Fast Track I with a refund or no charge
February 26	Last day to withdraw from Spring early 8 weeks with W on transcript. No Refund
March 1	Last day to withdraw from Spring Fast Track I with a W on transcript. No refund
March 11	Last day of Spring early 8 week and Fast Track I courses
March 13 – 17	Spring Break – College Closed
March 20	Beginning of early registration for returning students for Summer and Fall 2023 semester
March 20	First day of Spring late 8 weeks
March 21	Last day to enroll in Spring late 8 weeks
March 26	Last day to withdraw from Spring late 8 weeks with refund or no charge
March 27	Beginning of open registration for Summer and Fall 2023
April 10	First day of Fast Track II
April 16	Last day to withdraw from Spring 16 week with a W on transcript. No Refund
April 16	Last day to withdraw from Spring Fast Track II with a refund or no charge
April 30	Last day to withdraw from late 8 week with a W on transcript. No Refund.
May 3	Last day to withdraw from Fast Track II with W on transcript. No Refund.
May 11-13	Commencement
May 13	Last day of Spring 23 16 weeks, late 8 weeks, and Fast Track II
May 15	May intersession begins
Prior to Third Class Period	Last day to drop May intersession with a refund
May 24	Last day to drop May intersession with a W on transcript. No Refund
May 26	Last day of intersession

January 20, 2022

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May 29	Memorial Day – College Closed
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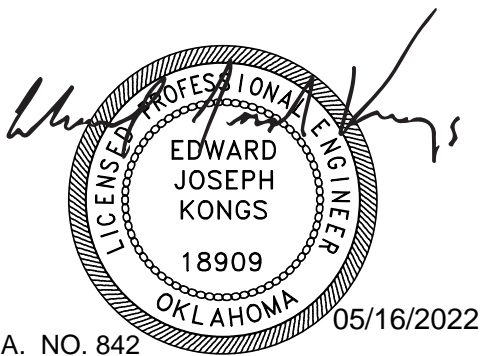
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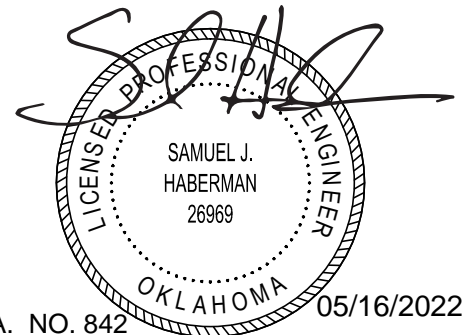
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C.A. NO. 842
EXPIRES 30/JUNE/2022



C.A. NO. 842
EXPIRES 30/JUNE/2022

SECTION 23 04 00
COMMON REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the general requirements of these specifications and shall apply to all phases of the work indicated or required to provide for complete installation of all systems for this project.
- B. This Section includes basic materials and methods to complement other Division 23 Sections.

1.2 WARRANTIES

- A. Warrant all materials, workmanship and equipment against defects for a period of one year after the date of substantial completion.
- B. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those divisions of the Project Manual.
- C. Repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period.
 - 1. Repair or replacement of compressorized equipment shall include a complete refrigerant charge.
- D. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner.
- E. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project.
- F. The repair of faulty workmanship shall be considered to be included in the contract.

1.3 QUESTIONS OF INTERPRETATION DURING BIDDING PHASE

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Engineer for clarification.
- B. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date.
- C. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents.
- D. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- E. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.4 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, request clarification from the Engineer before proceeding with the work.

- B. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Engineer.
- C. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Engineer was requested and obtained before submission of proposed methods or materials.
- D. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 DEFINITIONS

- A. The following definitions shall apply throughout the contract documents:
 - 1. Engineer: Architect or Engineer
 - 2. Code: All applicable national, state and local code
 - 3. Mechanical: All plumbing, HVAC, & fire protection work required by the Contract Documents
 - 4. Electrical: All electrical and fire alarm work required by the Contract Documents
 - 5. Contractor: Any Contractor performing work required by the Contract Documents
 - 6. Indicated: Shown on drawings, noted, scheduled or specified
 - 7. Selected: Selected by the Architect or Engineer
 - 8. Provide: Furnish, install, connect and tested complete and ready for use
 - 9. Furnish: Supply and deliver to the site ready for installation
 - 10. Install: Install complete, per Contract Documents and manufacturer's requirements.
 - 11. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - 12. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
 - 13. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
 - 14. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
 - 15. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 - 16. Dry Locations: A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.
 - 17. Damp Locations: Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.
 - a. Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold storage warehouses.
 - 18. Wet Locations: Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 SYMBOLS

- A. Items of equipment and materials are indicated on the drawings in accordance with the symbols shown on the plans.

1.7 ABBREVIATIONS

- A. Refer to abbreviations list shown on the Drawings.

1.8 CODES

- A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards.
- B. All work shall conform to all applicable sections of currently adopted editions of the following codes, standards, and specifications:
 1. International Building Code (IBC)
 2. International Fire Code (IFC)
 3. International Energy Conservation Code (IECC)
 4. International Fuel Gas Code (IFGC)
 5. International Plumbing Code (IPC)
 6. International Mechanical Code (IMC)
 7. Safety and Health Regulations for Construction
 8. Occupational Safety and Health Standards (OSHA), National Consensus Standards and Established Federal Standards
 9. National Electrical Code (NEC)
 10. National Fire Protection Association (NFPA)
 11. Life Safety Code (NFPA 101)
 12. American Gas Association (AGA)
 13. Underwriters' Laboratories, Inc. (UL)
 14. National Electrical Safety Code (NESC)
 15. All applicable national, state and local codes and amendments.

1.9 PERMITS

- A. The Contractors shall familiarize themselves with all requirements regarding all permits, fees, etc., and shall comply with them.
- B. All permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.
- C. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.10 CODE COMPLIANCE

- A. Work shall be in accordance with all applicable codes. Where the codes and drawings do not agree, the code shall take precedence; however, code shall take precedence over what is shown only when it is more stringent than that indicated. Items that are allowed by codes which are less stringent than that indicated shall not be substituted.
- B. Drawings, plans, and schematics and diagrams indicate the general location and the arrangement of systems. Wherever practical, install systems as indicated.
- C. Where the National Electrical Code or applicable codes require controllers to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment.

1.11 MATERIALS AND EQUIPMENT MANUFACTURERS

- A. Options in selecting materials and equipment are limited by requirements of the contract documents and governing regulations. They are not controlled by industry traditions or procedures experienced on previous construction projects.
- B. Materials and equipment shall be provided in accordance with the following:
 - 1. Primary Design Products: Primary design products are those products around which the project was designed in terms of capacity, performance, physical size and quality.
 - 2. Primary design products are indicated by use of a single manufacturer's name, model number or similar data on drawings or schedules or within the specifications.
 - 3. Provide primary design products unless substitutions are made in accordance with the following paragraphs.
 - 4. Acceptable Equivalent Substitutions: Acceptable equivalent substitutions are products of manufactures other than those listed for the primary design products. Equivalent acceptable substitutions shall meet each of the following requirements:
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the Project Manual, drawings, or addenda.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance, and physical characteristics.
 - c. The Contractor providing the substitution shall bear the total cost of all changes due to substitutions. These costs may include additional compensation to the Engineer for redesign and evaluation services, increased cost of work by the Owner or other Contractors, and similar considerations.
 - d. Performance Requirements: Where the contract documents list performance requirements or describe a product or assembly generically, provide products that comply with the specific requirements indicated and that are recommended by the manufacturer for the respective application.
 - e. Compliance with Standards, Codes and Regulations: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including the standards, codes and regulations.
 - f. Proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, delivery time requirements, and the availability of repair or replacement parts may also be considered.
 - g. The Engineer shall be the sole and final judge as to the suitability of substitution items.

1.12 SUBMITTALS

- A. Shop Drawings, Product Data and Samples:
 - 1. Other section in the Project Manual shall be adhered to if more stringent than the following paragraphs.
 - 2. When required by other sections of this Project Manual, submit shop drawings, product data or samples to the Engineer for review.
 - 3. Submittals deemed unnecessary by the Engineer shall be returned indicating "No Action Taken".

4. A completed copy of the transmittal form included with the Project Manual shall accompany each submittal.
 5. Submittals shall be labeled indicating the specification number and title, shop drawing or product data description and the respective Part 2 paragraph and sub-paragraph numbers.
 6. Submittals not listed in the Project manual shall reference the respective contract document.
 7. Unless otherwise noted, submit one copy electronically of shop drawings and product data for review. Review comments will be returned electronically. A hard copy of the electronic submittal will be returned if requested.
 - a. Shop drawings and product data shall be in original searchable PDF format.
 8. Shop drawings are drawings, diagrams, schedules and other data specifically prepared for this project by the Contractor, Manufacturer, Supplier, or Distributor to illustrate some portion of the work. Shop Drawings shall also detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
 - a. Shop drawings shall be drawn to accurate scale and of adequate size to illustrate required details.
 9. Product data are illustrations, standard schedules, performance charts, instruction brochures, diagrams and other information furnished by the Contractor, Manufacturer, Supplier, or Distributor to illustrate a material, product or system for some portion of the work.
 10. All submittals shall clearly indicate proposed items, capacities, characteristics and details in conformance with contract documents. All equipment items shall be marked with the same item number as used on drawings or schedules. Capacities, dimensions and special features required shall be certified by the manufacturer.
 11. Submittals shall indicate manufacturer's delivery time for the item after review by the Engineer.
 12. The Engineer shall review or take other appropriate action upon the Contractor's submittals such as shop drawings, product data and samples, but only to determine conformance with the design concept of the work and the information given in the contract documents.
 13. Contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Engineer's review of shop drawings, product data or samples.
 14. Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Engineer's review of those drawings.
 15. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Engineer. All such portions of the work shall be in accordance with reviewed submittals.
- B. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work.
1. Include the following:
 - a. Actual equipment being provided. Refer to manufacturer's data for physical size, access and maintenance requirements. Provide all code required clearances.
 - b. Planned piping layout, including valve and specialty locations and valve-stem movement.

- c. Clearances for installing and maintaining insulation.
- d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
- e. Equipment and accessory service connections and support details.
- f. Exterior wall and foundation penetrations.
- g. Scheduling, sequencing, movement, and positioning of large equipment into/onto building during construction.
- h. All Contractors are required to provide information concerning their part of the work needed to develop the coordination drawings.
- i. Drawings shall contain all of the following that are applicable:
 - 1) Ductwork, equipment, and terminal devices (showing access and service requirements). Ductwork, equipment and terminal devices indicated in the coordination drawing content must be the same as that indicated in all submittals.
 - 2) HVAC piping
 - 3) Structure and general construction
 - 4) Access doors and panels
 - 5) Other areas indicated by the Contractor that involve congestion
- j. Complete drawings after submitting product data on items included in coordination drawings.

C. Operation and Maintenance Manuals:

- 1. Prepare electronic operation and maintenance manuals for the equipment furnished.
- 2. The manual shall be in original searchable PDF format with equipment organized by specification section. Bookmarking shall be provided in the PDF for each specification section and piece of equipment.
- 3. Manuals shall be submitted to the Engineer for review and distribution to the Owner not less than 30 days prior to substantial completion of the project.
- 4. Manuals not meeting the requirements of this section may be rejected by the Engineer.
- 5. Manual shall include, but shall not be limited to, the following:
 - a. A cover page including:
 - 1) Project name and address
 - 2) Division of work covered by the manual
 - 3) Name, address and telephone number of Contractor and all Sub-Contractors including night or emergency numbers
 - b. A Complete Index. Contractor may submit the index to the Engineer for review prior to submittal of complete manuals if desired.
 - c. Manufacturer's equipment product data O&M manuals and parts lists identified by the equipment mark used in the contract drawings.
 - d. Names, Addresses and Telephone Numbers. This list shall include the manufacturer and local representative who stocks or furnishes repair parts for all items of equipment and shall be typed on a single page in front of the manual.
 - e. Startup, Operation and Shutdown Procedures. Provide a written description of procedures for startup, operation and shutdown of each item or system. This description shall include motors to start, valves to open, etc., in proper sequence, and the location of switches, starters, pushbuttons and valves. Description shall include item references or labels used in the contract documents unless otherwise instructed in advance by the Owner.

- f. Seasonal Changeover Procedure. Provide a written description of the procedure for necessary seasonable changeover from heating to cooling and vice versa.
- g. Equipment Accessory Schedule. Upon completion of the work, furnish the Owner with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required and the manufacturer of all renewable items.
- h. Lubrication Schedule. Provide a chart listing each piece of equipment, the proper type of oil or grease required, and recommended frequency of lubrication.
- i. Emergency Procedures. Provide a written description of emergency operating procedures or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency services to the various parts of the system.
- j. One copy of all shop drawings.
- k. Signed letters of certification of inspection and similar information.
- l. All manufacturers' warranty information.
- m. Provide documentation that training was performed for each item specified to include Owner training. Include name of Owner's representative(s) present, date and time of training.
- n. Normal Maintenance Schedule. Include a listing of work to be performed at various time intervals; i.e., 30, 90, 180 days and yearly.
- o. Provide documentation that Extra Materials were received by the Owner for each section requiring Extra Materials.
- p. Motor List. The list shall indicate motor location, equipment served (using labels indicated on drawings), horsepower, electrical characteristics, motor type, and rpm. Motors less than 1/2 horsepower need not be included.

1.13 OPERATING TRAINING

- A. Complete operating instructions for each system and item of equipment shall be provided to the Owner's designated personnel.
- B. Operation and Maintenance Manuals must be reviewed and accepted by the Engineer and provided to the Owner prior to operating training.
- C. Training shall be scheduled at the convenience of the Owner. A minimum of 4 hours, per system, of training shall be provided.
- D. Training shall include instructions on the following:
 - 1. Startup and shutdown procedures
 - 2. Seasonal changeover
 - 3. Periodic maintenance
 - 4. Emergency operation
 - 5. Safety
- E. In addition to the instructions required above, wherever possible perform the operations being described in order to fully illustrate system operation.
- F. At the completion of training, turn over to the Owner all required keys and special tools for installed equipment. Each key or tool shall be labeled with its use.

1.14 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel".

- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping".
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.15 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.16 COORDINATION

- A. Drawings, plans, and schematics and diagrams indicate the general location and the arrangement of systems. Wherever practical, install systems as indicated.
- B. Provide offsets and elevation changes in piping, conduit and ductwork as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
- C. Arrange for spaces, chases, slots, and openings in building structure during progress of construction to allow for system installations.
- D. Coordinate arrangement, mounting, and support of equipment.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
- E. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the installations that follow.
- F. Sequence, coordinate, and integrate installing materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- G. Coordinate service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing water, gas, electrical power and other services.
- H. Coordinate location of access panels and doors for items that are concealed by finished surfaces.

- I. Coordinate testing of items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.17 STRUCTURAL COORDINATION

- A. In cases where the Contractor determines that superimposed loads such as suspended or floor mounted mechanical, electrical, plumbing system or equipment exist which exceed design loads indicated on structural contract documents, Contractor shall submit load data to Design Professionals for review prior to proceeding with work.
- B. Distribute the maximum load hung from any structural member for mechanical, electrical, plumbing, ductwork, piping, etc. over the member's tributary area in a way that the design superimposed dead loads listed in structural contract documents are not exceeded. The Contractor shall coordinate the loads and provide additional support or distribution framing as required achieving the allowable load distribution.
- C. Connections of systems designed by Contractor's engineer such as, but not limited to mechanical, electrical, plumbing loads are assumed to impose vertical and/or horizontal loads on the base building structural members without generating torsion in the supporting structural members. Contractor is responsible for designing, furnishing and installing all supplementary bracing members as required to prevent torsion on the base building structure.
- D. Coordinate locations of new fire suppression, plumbing and HVAC penetrations through existing structure and construction. Utilize all existing documentation of conditions for coordination. Verify penetrations utilizing GPR (Ground Penetrating Radar) as necessary to confirm penetration locations.

PART 2 - PRODUCTS

2.1 PERFORMANCE, CAPACITIES AND CHARACTERISTICS

- A. See Drawings for Specific Notes and/or Equipment Schedules with Equipment Performance Requirements when capacities and characteristics are not indicated in the specifications.

2.2 EQUIPMENT SHORT CIRCUIT CURRENT RATING

- A. Where the National Electrical Code or applicable codes require equipment to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment. Acceptable methods of complying with this requirement are as follows:
 - 1. Provide SCCR rating at the equipment that meets or exceeds the available short circuit current at the switchboard or panelboard where the equipment circuit originates.
 - 2. Provide calculations, based on the available short circuit current at the switchboard or panelboard where the equipment circuit originates, that document the actual short circuit current available at the equipment. The SCCR rating of the equipment shall meet or exceed this calculated value.

2.3 CONTROL SYSTEM INTERFACES

- A. Equipment and systems shall be able to interface and integrate to the existing Trane BMCS systems and sequences via , BACnet. No exceptions.
- B. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
 - 1. Manufacturer's packaged system controllers and control panels.

2. Variable Frequency Controllers.

2.4 MATERIALS

- A. Unless otherwise specified, all materials and equipment shall be new, unused and undamaged. Materials and equipment shall be the current and standard designs of manufacturers regularly engaged in their production.

2.5 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

- A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details and requirements.

2.6 QUANTITY OF SPECIFIED ITEMS REQUIRED

- A. Wherever in these specifications an article, device or piece of equipment is referred to in the singular number; such reference shall apply to as many such articles as are shown on the drawings or required to complete the installation.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast Brass Type: With set screw.
1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 PIPE OR CONDUIT PENETRATION HOUSING & HOODS

- A. Manufacturer:
1. RPH; www.RoofPenetrationHousings.com
- B. References:
1. ICC-500, FEMA 320/361 – Third Party Tested to +225 mph
2. ICC 2015 Energy Code – Third Party Tested to ASTM E 2078-13 Standard Test Method for Air Permeance of Building Materials
3. ASTM E 1980 Solar Reflectance Index (SRI)
4. FEMA P749 – Seismic Provisions
- C. Lid and housing lined with insulation to a minimum value of R-19.
- D. Warranty: 20 years.

- E. Roof Mounted: Engineered penetration housing, accommodating up to 18 pipes/conduits- cables, water, refrigeration, and power in one roof penetration with high rain tight integrity.
- F. Roof penetration system is constructed of 14 gauge UV powder coated, welded, galvanized steel or aluminum with stainless steel hardware.
 - 1. Removable, gasketed lid to housing and housing to curb connection joints, pitched cover.
 - 2. Exit seal construction to be manufactured in all aluminum construction and 100% Sil-X-14 silicone gaskets.
 - 3. All seals must be protected from UV with an aluminum or stainless steel jacket.
- G. Coordinate size of housing and hoods with all trades utilizing the penetration.
- H. Furnish with 18-inch tall insulated curb and extensions for roof applications.

2.9 ROOF MOUNTED PIPE, DUCTWORK AND CONDUIT SUPPORT SYSTEMS

- A. Manufactures:
 - 1. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 - 2. Eaton, Dura-Blok.
 - 3. Erico International Corporation: www.erico.com.
 - 4. PHP Systems/Design, www.phpsd.com
 - 5. Unistrut, UNIpier.
- B. Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - 1. Bases: UV resistant material, molded polycarbonate resin, HDPE or rubber.
 - 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Stut style, galvanized steel horizontal and vertical supports, attaching hardware.
 - 4. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 5. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - 6. Height: Provide minimum clearance of 18 inches under pipe to top of roofing.
 - a. Adjustable mounting height.
 - 7. Operating temperature: -30F to 150F.

2.10 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psig, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.11 SEALANTS AND FIRESTOPPING

- A. Manufacturers:
 - 1. Sealants:
 - a. Dow Corning
 - b. Pecora
 - c. Sonneborn

- d. Tremco
- 2. Firestopping Materials and Systems:
 - a. A/D Fire Protection Systems Inc: www.adfire.com.
 - b. 3M Fire Protection Products: www.3m.com/firestop.
 - c. Hilti, Inc: www.us.hilti.com.
 - d. Nelson FireStop Products: www.nelsonfirestop.com.
 - e. Specified Technologies, Inc: www.stifirestop.com.
 - f. Tremstop Fyre-Sil Sealant - Tremco Sealants & Coatings
- B. Silicone Sealant: Single component, air curing, non-staining, non-bleeding, capable of continuous water immersion, non-sagging type for application in vertical joints and in horizontal joints, color as selected.
- C. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- D. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- E. Joint Backing: ANSI/ASTM D1056; round, closed cell, polyethylene foam rod; oversized 30% to 50% larger than joint width.
- F. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
- G. Firestopping Materials and Systems:
 - 1. UL Listed products and assemblies.
 - 2. Subject to compliance with the requirements of Division 07.

2.12 ACCESS DOORS

- A. Manufacturers:
 - 1. Access Doors:
 - a. J. L. Industries
 - b. Karp Associates, Inc.
 - c. Larsons Mfg. Co.
 - d. Milcor, Inc.
 - e. Miller Limited Partnership
 - f. Nystrom, Inc.
- B. Prime coated 14 gauge steel, flush, with screwdriver operated cam lock, frame to accommodate construction type; size as indicated.

2.13 ELECTRICAL WIRE

- A. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable.
- B. All wiring running exposed in return air plenums shall be plenum-rated cable for fire and smoke spread.

2.14 LOW VOLTAGE CONTROL WIRE AND CABLE

- A. All wiring materials section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable.
- B. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC, and General Purpose Cabling:
 - 1. Cable shall consist of copper conductors not less than #18 AWG stranded.

2. Cable shall be two- or three-conductor twisted cable with a drain wire.
 3. Cable shall have a 100 percent overall shield.
 4. Cable shall be plenum rated.
 5. Cable shall meet or exceed NEC voltage rating of 300 volts.
 6. Cable shall be NEC type CMP.
 7. Cable shall meet or exceed UL temperature rating of +60 deg C.
- C. Primary and Secondary Communications Network Cabling:
1. Cable shall be of type recommended by the DDC system manufacturer.
 2. Cable shall be shielded.
 3. Cable shall be plenum rated.
 4. Cable shall meet or exceed NEC voltage rating of 150 volts.
 5. Cable shall meet or exceed UL temperature rating of +60 deg C.

PART 3 - EXECUTION

3.1 GENERAL

- A. Fabrication, erection, and installation of the complete mechanical system shall be done by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up the progress of the project.
- B. The Contractor shall check all areas and surfaces where mechanical equipment or materials are to be installed and report any unsatisfactory conditions before starting work.
- C. Commencement of work signifies the Contractor's acceptance of the conditions as fit and proper for the execution of the mechanical work.
- D. Equipment and systems shall be installed in accordance with manufacturer's instructions, requirements, or recommendations.

3.2 DELIVERY AND STORAGE OF MATERIALS

- A. Take provisions for the delivery and safe storage of materials and shall make the required arrangements with other Contractors for the introduction into the building of equipment too large to pass through finished openings.
- B. Materials shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.
- C. Contractor shall be responsible for adequately protecting all supplies and equipment during cold weather.
- D. All items subject to cold weather damage shall be protected by covering, insulating, or storing in a heated space.

3.3 COOPERATION WITH OTHER CONTRACTORS

- A. Perform the work in conformance with the construction called for by other trades and afford other Contractors reasonable opportunity for the execution of their work.
- B. Properly connect and coordinate the mechanical work with the work of other Contractors at such time and in such a manner as not to delay or interfere with their work.
- C. Examine the contract documents for the General, Mechanical, and Electrical work and the work of other trades. Coordinate work accordingly.

- D. Promptly report to the Engineer any delay or difficulties encountered in the installation of the mechanical work which might prevent prompt and proper installation of work required from other trades.
- E. Systems Test and Balance Contractors or personnel shall coordinate their work with the contractors who installed the systems being tested or balanced.
- F. The Temperature Control Contractor or personnel shall be present during systems test and balance.

3.4 COORDINATION OF WORK

- A. The list below is the precedence of assigned work items for space priority in descending order. Items not listed shall have the same precedence as similar items.
 - 1. Reflected ceiling with all light fixtures, access above light fixtures required for maintenance, sprinkler head locations, and all ceiling fixtures and devices.
 - 2. Space designed for future utility placement.
 - 3. Gravity flow plumbing waste, roof drainage, and other systems that rely upon gravity for flow.
 - 4. Ductwork and appurtenances, except that external bracing shall be relocated to accommodate local interference.
 - 5. Fire sprinkler piping.
 - 6. Cable tray with access identification 8 inches horizontal to 6 inches above tray.
 - 7. Electrical conduit over 2 inches in diameter.
 - 8. HVAC piping except for pressurized domestic water piping.
 - 9. Plumbing vents.
 - 10. Electrical conduit under 2 inches in diameter.
- B. Plan all work so it proceeds with a minimum of interference with other trades.
- C. It shall also be the responsibility of the Mechanical Contractor to inform the Contractor of all openings required in the building construction for the installation of the mechanical work.
- D. The Contractor shall cooperate with all other contractors in furnishing material and information, in proper sequence, for the correct location of all sleeves, inserts, foundations, wiring, etc.
- E. Provisions shall be made for all special frames, openings, and sleeves as required.
- F. The Contractor shall pay for extra cutting and patching made necessary by his failure to properly direct such work at the correct time.

3.5 ELECTRICAL WIRING

- A. Install wiring in accordance with National Electric Code, ANSI/NFPA 70.
- B. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable. All wiring running exposed in air plenums shall be plenum cable.
- C. Install wiring (low and line voltage) in metal raceways or conduit unless inside control cabinet or unit enclosures.
 - 1. For concealed and accessible areas, plenum-rated wiring and cabling may be used.
- D. Low voltage wiring not installed in conduit shall be supported every five feet from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance

with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.

- E. Low voltage control wiring and 24 VAC can be run in the same conduit. Power wiring 120 VAC and greater must be in a separate conduit.
- F. Fastening shall be secured to walls or ceilings by means of appropriate screws, expansion screws anchors, toggle bolts, hollow wall screw anchors, nylon expansion anchors, or expansion shields. All-purpose plastic anchors are not acceptable.
- G. Locate circuits, relays, transformers, or other equipment that contains or must be connected to voltages exceeding 130 volts, in separate cabinets, which may be adjacent to control panels; permanently label "DANGER 277 VOLTS" or appropriate volts.
- H. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size shall be 3/4 inch.

3.6 CONTROL WIRING AND POWER CONNECTIONS

- A. Provide all incidental control power and wiring required to make the equipment or systems fully operational. Coordinate with equipment manufacture incidental wiring requirements.
- B. Unless indicted elsewhere, provide line voltage, 120VAC, 20 amp dedicated control power circuits and LAN outlet to each of the following and as indicated:
 - 1. Each BMCS Control panel, 1 circuit.
 - 2. Air handling Unit, 1 circuit.
 - 3. Air Terminal Unit Power supply transformer panel, 1 circuit per 20 terminal units.
 - 4. DDC Power supply and transformer panel. 1 circuit can power 30 terminal units.
 - 5. Coordinate required 120V power circuits and LAN outlets with Electrical Contractor.
- C. Incidental control wiring includes but not limited to:
 - 1. Air Handling Units:
 - a. Fans
 - b. Damper Operators
 - c. Lights
 - d. UVC
 - e. Valve Operators
 - 2. Equipment Motors Starters
 - 3. HVAC Controls (Including but not limited to):
 - a. Manufacturer's Packaged Control Systems
 - b. Control Relays
 - c. Air Terminal Units, dual duct terminal boxes
 - d. Control Dampers and Valves
 - e. Transmitters
 - 4. Pushbutton Stations and Emergency Stop Switches
 - 5. Remote Monitoring and Control Panels (Provided by Equipment Manufacturers)
 - 6. Smoke Dampers at Air Handling Units
 - 7. Supply, Return and Exhaust Fans
 - 8. Temporary Heating/Cooling Equipment
 - 9. Unit Mounted Motor Starters, Contactors, Disconnect Switches, Thermal Overloads and Heaters
 - 10. Variable Frequency Controls.

3.7 LAYING OUT WORK

- A. Carefully lay out all work in advance of installation using data and measurements from the site, the appropriate architectural and structural drawings, and shop drawings.
- B. Equipment layout and all system layouts shall confirm adequate clearances for installation, operation, maintenance, and code-required clearances from the structure or other equipment and systems.
- C. Provide offsets and elevation changes in piping, conduit and ductwork as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
- D. The layout shall not cause problems of operation, maintenance, or clearance for items installed by other Contractors.
- E. Prior to installation of any work, make certain the location does not conflict with other items in or near the same location.
- F. If the layouts so prepared indicate that the required conditions cannot be met in the space provided, inform the Engineer prior to installation and shall request clarification.
- G. Failure to properly coordinate and lay out the work will require correction by the Contractors at their own expense.

3.8 DATA AND MEASUREMENTS

- A. Mechanical and electrical drawings are diagrammatic or schematic. Do not scale drawings.
- B. The data given herein and on the drawings is as accurate as could be secured; absolute accuracy is not guaranteed.
- C. Obtain exact locations, measurements, levels, etc., at the site and shall adapt their work to actual conditions.
- D. Examine the general construction, mechanical, electrical, and other applicable drawings and the Specifications.
- E. Only site measurements may be utilized in calculations.
- F. Layout and coordinate all work prior to installation to provide clearances for operation, maintenance and codes. Verify non-interference with other work.

3.9 POSITION OF DEVICES

- A. Locate devices mounted on finished surfaces with regard to paneling, furring, trim, etc. Where several devices occur in a room, they shall be symmetrically arranged as reviewed by the Engineer.
- B. Devices improperly located or installed shall be repaired, replaced or relocated at the Contractor's expense.
- C. Devices shall be set plumb or horizontal and shall extend to the finished surface of the wall, ceiling, or floor without projecting beyond the surface.
- D. Devices shown on wood trim, cases, or other fixtures shall be installed symmetrically and, where necessary, shall be set with the long dimension of the plate horizontal.

- E. Coordinate their respective devices so as not to destroy the aesthetic effect of the surface in which the devices are mounted.
- F. Coordinate the locations of all mechanical items with work furnished by other trades to avoid interference.
- G. If the required coordination is not done, the outlets or devices shall be removed and relocated if so directed by the Engineer and the damaged surfaces repaired at the Contractor's expense.
- H. Devices shall be installed at the height shown below unless otherwise noted. All heights of devices are measured from finished floor to centerline of device.
- I. Heights may be adjusted to correspond to nearest masonry course or as necessary to clear wall-mounted cabinets, fin tube convectors, unit heaters, etc.
 - 1. Temperature control panels: 60 inches
 - 2. Thermostats: 48 inches

3.10 PROTECTION OF APPARATUS

- A. Take such precautions as necessary to properly protect all apparatus, fixtures, appliances, material, equipment, and installations from damage of any kind.
- B. Failure to provide such protection to the satisfaction of the Engineer shall be sufficient cause for the rejection of any particular piece(s) of material, apparatus, equipment, etc., concerned.

3.11 ACCESS TO EQUIPMENT

- A. All motors, terminal boxes, valves, control devices, specialties, etc., shall be located to provide for easy access for operation, repair and maintenance; if concealed, access doors shall be provided.
- B. Access doors required for access to equipment requiring inspection or service shall be provided.
- C. Provide all access doors not already furnished by other Contractors but which are required for access to mechanical equipment.
- D. Doors shall be 12 inches by 12 inches unless shown otherwise.
- E. Person access doors shall be 18 inches by 18 inches minimum.

3.12 EXAMINATION OF PREMISES

- A. Examine the premises and all conditions thereon and/or therein. The bid proposal shall take into consideration all such conditions which may affect the work under this contract.
- B. Prior to commencement of work contractor shall provide to owner a schedule of work activities that shall be coordinated with the owners building occupancy schedule to facilitate the educational process. All work shall be scheduled so that the owners existing educational schedule shall not be disrupted.

3.13 ROADWAYS, CURBS, AND WALKS

- A. Use every possible precaution to prevent injuries to roadways, curbs, and walks on or adjacent to the site of the work.
- B. Any damage shall be repaired at the Contractor's own expense. This shall also include damage necessary for installation of the mechanical work.

3.14 WORK IN EXISTING BUILDINGS

- A. General: All work in the existing building, indicated on the drawings or specified herein, shall be executed with a minimum amount of interference with the normal activities of the occupants of the building.
- B. All work shall be scheduled in advance with the Owner and shall not proceed without the Owner's written approval.
- C. Utilities: Utilities shall not be interrupted without the Owner's prior written approval regarding the time and duration of such interruptions.
 - 1. Utilities to existing facilities shall not be disconnected until new or temporary facilities are installed except for short periods of interruption which are necessary for the performance of the new work and which are approved by the Owner.
- D. Storm water may be temporarily diverted to surface drainage provided such drainage is arranged to prevent flooding of structures, basements, and excavations for construction.
- E. Fire Alarm System: The existing fire alarm system shall remain functional throughout construction.
 - 1. As a minimum, the existing degree of protection shall be maintained for all areas.
 - 2. All required outages shall be coordinated with the Owner and the Fire Marshal.
- F. Welding: The Owner shall be notified before starting welding or cutting.
 - 1. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc.
 - 2. Welding or cutting with an open flame or arc shall be stopped not less than one hour before leaving the premises.
- G. Noisy Operations: Noisy operations such as those involving use of air hammers, etc., in demolition, or cutting of openings shall be scheduled with the Owner.
- H. Occupancy:
 - 1. The Owner will continue to occupy the building and carry on normal activity. Each Contractor shall protect the occupied areas from dust, smoke, etc., by a method reviewed by the Engineer.
- I. Owner's Right to Direct Work: The Owner shall have the right to direct the places of beginning work, its prosecution, and the manner in which all work under this contract is to be conducted, insofar as may be necessary to secure the safe and proper progress and quality of the work.
- J. Coordinate locations of new fire suppression, plumbing and HVAC penetrations through existing structure and construction. Utilize all existing documentation of conditions for coordination. Verify penetrations utilizing GPR (Ground Penetrating Radar) as necessary to confirm penetration locations.
- K. Cutting and Patching:
 - 1. Each Contractor shall be responsible for all cutting and patching required for the work.
 - 2. Patching shall be done by persons skilled in the trade involved and shall be prepared to receive paint.
 - 3. Openings through floors may be drilled up to 1 inch but shall be core drilled over 1 inch.
 - 4. Whenever the building surfaces (walls, ceilings, etc.) and openings are modified, removed and/or replaced to accommodate installation of the new work/equipment or to introduce into or remove items from the building, such surfaces or openings shall be carefully reinstalled or replaced to match existing

and in conformance with the applicable code to protect the integrity of the building.

- L. Existing Piping, Ductwork, or Mechanical Equipment:
 - 1. If any existing piping, ductwork or mechanical equipment is encountered which would interfere with the proper installation of new work, it shall be removed or relocated as required or as directed by the Engineer.
 - 2. Where existing work is to be modified, it shall be done in conformance with these specifications.
 - 3. Materials used shall be the same as for new work unless otherwise specified.

3.15 DEMOLITION

- A. Information pertaining to the existing building has been obtained through the buildings original drawings where available. Report discrepancies to the architect/engineer prior to any demolition. Contractor shall field verify all existing conditions prior to commencing work.
- B. The Owner shall have the first right of salvage for all items being removed or demolished. If owner declines, the contractor shall remove from the premises and dispose of properly. Verify owner's intent prior to removal or demolition.
- C. Coordinate shut down of all utilities for demolition work with the owner.
- D. Coordinate demolition with the work of other trades. Provide temporary utilities as required to allow the work of other trades to proceed.
- E. Remove all items and systems as indicated.
- F. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- G. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.16 FRAMES

- A. Ducts passing through masonry walls shall be installed in steel angle iron frames and sleeves.
- B. All sleeves and frames shall be securely fastened to the walls. Provide for structural lintels in masonry wall openings.

- C. Ducts passing through openings in poured concrete walls and floors need not have frames.

3.17 FINISHED SURFACES PENETRATIONS

- A. All piping and ductwork penetrations of finished surfaces shall have escutcheons and/or closure plates.
- B. Openings shall be cut only as large as required for the installation, sleeves, and/or frames installed flush with finished surfaces and grouted in place.
- C. Surfaces around openings shall be left smooth and finished to match surrounding surface.
- D. Duct frames and pipe sleeves through floors in concealed locations and in unfinished spaces such as mechanical rooms, etc., shall extend 2 inches above finished floor level and shall be caulked watertight.
- E. All other sleeves shall extend approximately 1/4 inch above finished floor but shall allow placement of escutcheons.

3.18 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

- A. Subject to compliance with the requirements of Division 07.
- B. Provide proper sizing when providing sleeves or core-drilled holes to accommodate their work through penetrating items.
- C. All voids between sleeve or core-drilled hole and pipe passing through shall be firestopped to meet the requirements of ASTM E814.
- D. Install all materials complete, attached securely and permanently in place in accordance with manufacturers' printed directions.
- E. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- F. Do not cover installed firestopping until inspected by authority having jurisdiction.
- G. Install labeling required by code.

3.19 PIPING AND/OR DUCTWORK SYSTEMS - COMMON REQUIREMENTS

- A. General: Install as described below, unless individual Sections specify otherwise. Individual Sections specify unique installation requirements.
- B. General Locations and Arrangements:
 - 1. Drawing plans, schematics, and diagrams indicate general, diagrammatic location and arrangement of systems.
 - 2. Indicated locations and arrangements were used to size pipe or ductwork and calculate friction loss, expansion, pump and fan sizing, and other design considerations.
 - 3. Install systems as indicated, unless deviations to layout are approved on Coordination Drawings.
 - 4. Provide offsets and elevation changes in ductwork, piping and conduit as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
 - 5. Do not run ductwork and piping above electrical panels or in code required clearance spaces.

6. Do not run ductwork, piping, and plumbing above or through information technology and data closets, IDF, and MDF rooms. Coordinate all routing with other trades.
7. Coordinate location of ductwork and piping with electrical cable tray. Provide a minimum of 6" of clear access above cable tray for installation of cables.
8. Install exposed interior and exterior piping and ductwork at right angles or parallel to building walls.
 - a. Diagonal runs are prohibited, unless otherwise indicated.
9. Conceal ductwork and piping in walls, pipe chases, utility chases, above ceilings, below grade or floors, unless otherwise noted, except in mechanical rooms or service areas.
10. Install piping and ductwork to allow application of insulation plus 1-inch clearance around insulation.
11. Pipe hangers for insulated pipe with vapor barrier jackets shall be installed around the outside of the insulation and a metal insulation support shield provided to prevent crushing of the insulation.
12. Dielectric nipples or flange insulation kits shall be utilized for all dissimilar pipe connections. Dielectric unions will not be accepted.
13. Install piping at indicated slope and as required by code.
14. Provide components with pressure rating equal to or greater than system operating pressure.
15. Install fittings for changes in direction and branch connections.
16. Install piping free of sags or bends with ample space between piping to permit proper insulation applications.
17. Install ductwork and piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building unless otherwise indicated.
 - a. Allow sufficient space above ceiling panels to allow for ceiling panel removal.
18. Install ductwork and piping to allow for expansion and contraction without stressing pipe, adjacent building structure or connecting equipment.
19. Do not use ceiling support system to bear weight of devices or systems unless ceiling support system is certified as suitable to do so.
20. During construction, avoid any undue loads, forces or strains on valves, equipment, pumps flanges, or building elements with piping connections or piping systems.
21. Keep all pipe, duct, and equipment openings closed during construction except when actual work is being performed on that item or system.
22. Leaking pipe and duct joints shall be remade using new materials.
23. Roof mounted piping, conduit and ductwork:
 - a. Coordinate all roof mounted support locations and loads with roofing contractor.
 - b. Space supports per all applicable codes and as indicated.
 - c. Provide 18" minimum under pipe, duct and conduit, to allow for roof repair.
24. Piping Penetrations:
 - a. Provide pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1) Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2) Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.

- 3) Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4) Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5) Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- C. Contractor is responsible for any cutting and patching needed for mechanical installation. Patching must match existing.
 - D. Size and route refrigerant piping per manufacturers' recommendations.
 - E. Verify final equipment locations for roughing-in of all systems.
 - F. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.20 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to manufacturer's requirements and submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Engineer.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components.
- E. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- F. Install equipment giving right of way to piping installed at required slope.
- G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.21 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.22 INCIDENTAL WORK

- A. The following incidental work shall be furnished by the designated contractor under the supervision of the Temperature Control Contractor:
 - 1. The Piping Contractor shall install automatic valves and separable wells that are specified to be furnished by the Temperature Control Contractor.
 - 2. The Piping Contractor shall provide all necessary valved pressure taps, water, drain, and overflow connections and piping.
 - 3. The Piping Contractor shall provide all necessary piping connections required for flow devices, valve position indicators, etc.
 - 4. The Electrical Contractor shall provide power wiring to the variable frequency drives.
 - 5. Supply and return air motorized smoke dampers shall be provided by the Air Distribution Contractor on all air handling units 15,000 cfm and larger, as

required by NFPA 90A, and shall be controlled by the Temperature Control Contractor. Dampers shall close when fan stops and open when fan starts.

3.23 EQUIPMENT AND SYSTEM SOFTWARE INTERFACES TO THE BMCS

- A. Contractor shall coordinate with the BMCS Contractor to determine the points that are to be mapped from the equipment and systems to the BMCS. Contractor shall provide details of the method of integration and the information to be transferred between the systems as part of the submittal package.
- B. Contractor shall provide the necessary software communication ports specifically for the interfacing of the systems to the BMCS.
- C. Contractor cannot document that the exact same interface has been performed between the selected BMCS and the equipment and/or system, then the interfaces shall be tested prior to installations at an offsite location. The equipment shall not be installed at the project location until all software interfaces to the BMCS have been successfully demonstrated or documented.
- D. Documentation regarding the software interfaces shall be provided in sufficient detail as to enable a person reasonably skilled in the writing of real time software applications to add/delete points mapped from one system to the other. The documentation shall include a detailed description of each protocol used and the model, version and firmware details of any protocol converter (gateway) that is used.
- E. Refer to BMCS specifications for coordination and testing requirements.

3.24 LUBRICATION, TESTING AND TEST REPORTS

- A. Upon completion of the work, the entire system shall be tested and proven for capacity of equipment, balance of system, proper operation of controls, and comfort of conditioned spaces.
 - 1. Prior to beginning systems testing, adjusting and balancing, replace all filter media with new media.
 - 2. Test and balance procedures and documentation shall be in accordance with AABC, NEBB, or SMACNA unless indicated otherwise.
 - 3. Take air and water flow readings and submit copy of same to demonstrate proper flow according to the performances shown on the plans and noted in the specifications.
 - 4. Motors shall be checked for overload and belts adjusted.
 - a. Align pulleys and install belts according to manufacturer's written instructions.
 - b. Tension according to manufacturer's written instructions.
 - 5. Lubricate moving parts and clean or replace filters.
 - a. Run in all bearings and, after they are run in, drain and flush bearings and refill with a new oil charge.
 - b. Equipment shall be so arranged that tools (screwdrivers, wrenches, etc.) will not be required to make lubrication points accessible.
 - c. Extensions on grease or oil fittings shall be provided where required for access to lubricate.
 - 6. Test piping systems per applicable codes and standards.
 - 7. Test ductwork systems per SMACNA and applicable codes and standards.
 - 8. Submit all test reports to the Engineer for review prior to date of substantial completion.

9. Equipment and systems discrepancies shall be corrected prior to final acceptance.

END OF SECTION 23 04 00

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Three phase electric motors.

1.2 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
- C. NEMA MG 1 - Motors and Generators.
- D. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- C. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Baldor Electric Company/ABB Group: www.baldor.com.
- B. Leeson Electric Corporation: www.leeson.com.
- C. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com.
- D. General Electric

E. U.S. Motors

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Construction:

1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

C. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

D. Motors located outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-sealed type.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000

hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

- I. Sound Power Levels: To NEMA MG 1.
- J. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- K. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- L. Nominal Efficiency: NEMA MG 1-2006 Premium.
- M. Inverter Duty: NEMA MG 1 Part 31.4.4.2.

2.5 SHAFT GROUNDING

- A. Manufacturers:
 - 1. AEGIS SGR
 - 2. Helwig Carbon Products
- B. Shaft grounding system for each three-phase AC motor to prevent electrical damage to motor bearings and to extend motor life by safely channeling harmful shaft currents to ground.
- C. Provide shaft grounding on all motors controlled by variable frequency controllers and as indicated.
- D. Electrographite construction. Integral shunt with quick disconnect terminal and mount.
- E. Continuous spring loaded brush holder, conductive carbon brush or carbon fiber ring technology.
- F. Replaceable without motor removal or uncoupling..
- G. Internal:
 - 1. Integral to motor housing.
- H. External:
 - 1. Bolted to motor exterior.
 - 2. Slide ring over the end of the motor shaft and locking it in place with screw on mounting brackets.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.2 SCHEDULE

- A. NEMA Open Motor Service Factors.
 - 1. 1.5-150 hp:
 - a. 3600 rpm: 1.15.

- b. 1800 rpm: 1.15.
- c. 1200 rpm: 1.15.
- d. 900 rpm: 1.15.

END OF SECTION 23 05 13

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.
- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.

- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Engineer.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified below and in Part 3.
 - 4. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Engineer and other installers to sufficiently understand the design intent for each system.
 - 5. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Total flow calculations.
 - 2) Rechecking.
 - 3) Diversity issues.
 - h. Expected problems and solutions, etc.
 - i. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - k. Confirmation of understanding of the outside air ventilation criteria under all conditions.

- l. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - m. Method of checking building static and exhaust fan and/or relief damper capacity.
 - n. Proposed selection points for sound measurements and sound measurement methods.
 - o. Methods for making coil or other system plant capacity measurements, if specified.
 - p. Time schedule for deferred or seasonal TAB work, if specified.
 - q. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - r. Procedures for formal progress reports, including scope and frequency.
 - s. Procedures for formal deficiency reports, including scope, frequency and distribution.
- B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 - 3. Provide reports in electronic, word searchable, .pdf format binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in I-P (inch-pound) units only.
 - 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Engineer.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
 - k. Certification sheet signed and sealed by the certified testing and balancing engineer.
- C. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
- 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- D. Project Record Documents: Record actual locations of flow measuring stations, balancing valves and rough setting, and balancing dampers.
- E. Final Report Contents: In addition to certified field report data, include the following:
- 1. Fan curves.

2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

1.5 PROJECT CONDITIONS

- A. The entire TAB process shall be completed prior to Substantial Completion.

1.6 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

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

PART 2 PRODUCTS

2.1 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 2. SMACNA (TAB).
 3. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Air coil fins are cleaned and combed.
 - 8. Access doors are closed and duct end caps are in place.
 - 9. Air outlets are installed and connected.
 - 10. Duct system leakage is minimized.
- B. Examine equipment performance data that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- D. Examine system and equipment test reports.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine equipment for installation and for properly operating safety interlocks and controls.
- K. Examine automatic temperature control and building automation system components to verify the following:
 - 1. Check the sequence of operation of control devices are according to the Contract Documents..
 - 2. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 3. Dampers and valves are in the position indicated by the controller.
 - 4. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 5. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 6. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 7. Sensors are located to sense only the intended conditions.
 - 8. Controller set points are set at indicated values. Controllers are calibrated and commissioned. Record controller settings and note variances between set points and actual measurements.
 - 9. Changeover from heating to cooling mode occurs according to indicated values.
 - 10. Transmitter and controller locations and note conditions that would adversely affect control functions.
 - 11. Operation of limiting controllers (i.e., high- and low-temperature controllers).
 - 12. Free travel and proper operation of control devices such as damper and valve operators.
 - 13. Interaction of electrically operated switch transducers.
 - 14. Interaction of interlock and lockout systems.
 - 15. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
 - 16. Note operation of electric actuators using spring return for proper fail-safe operations.
- L. 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.
- M. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

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

3.6 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. Check and adjust systems approximately six months after final acceptance and submit report.

3.7 AIR SYSTEM PROCEDURE

- A. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- B. Check dampers for proper position to achieve desired airflow path.
- C. Check for airflow blockages.
- D. Check condensate drains for proper connections and functioning.
- E. Check for proper sealing of air-handling unit components.
- F. Check for proper sealing of air duct system.
- G. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

- H. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- I. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- J. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- K. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- L. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- M. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- N. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- O. Compensating for Diversity in Variable Volume Systems: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

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

3.9 SCOPE

- A. Test, adjust, and balance the following:
 1. Air Handling Units.
 2. Fans.
 3. Air Filters.
 4. Air Terminal Units.

3.10 MINIMUM DATA TO BE REPORTED

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

8. Sheave Make/Size/Bore.
 9. Motors Driven by Variable-Frequency Controllers:
 - a. Test for proper operation at speeds varying from minimum to maximum.
 - b. Test the manual bypass for the controller to prove proper operation.
 - c. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.
- B. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Saturated suction temperature, design and actual.
 15. Air pressure drop, design and actual.
- C. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- D. Air-Handling Unit:
1. Unit identification.
 2. Location.
 3. Make and type.
 4. Model number and unit size.
 5. Manufacturer's serial number.
 6. Unit arrangement and class.
 7. Discharge arrangement.
 8. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

- g. Variable frequency controller position.
 - 9. Total airflow rate in cfm.
 - 10. Return air flow, specified and actual
 - 11. Outside air flow, specified and actual
 - 12. Total system static pressure in inches wg.
 - 13. Fan rpm.
 - 14. Discharge static pressure in inches wg.
 - 15. Filter static-pressure differential in inches wg.
 - 16. Outside-air damper position.
 - 17. Return-air damper position.
- E. Supply and Return Fans:
- 1. Unit identification.
 - 2. Location.
 - 3. Manufacturer.
 - 4. Model number.
 - 5. Serial number.
 - 6. Arrangement/Class/Discharge.
 - 7. Air flow, specified and actual.
 - 8. Total static pressure (total external), specified and actual.
 - 9. Inlet pressure.
 - 10. Discharge pressure.
 - 11. Sheave Make/Size/Bore.
 - 12. Number of Belts/Make/Size.
 - 13. Fan RPM.
- F. Return Air/Outside Air:
- 1. Identification/location.
 - 2. Design air flow.
 - 3. Actual air flow.
 - 4. Design return air flow.
 - 5. Actual return air flow.
 - 6. Design outside air flow.
 - 7. Actual outside air flow.
 - 8. Return air temperature.
 - 9. Outside air temperature.
 - 10. Required mixed air temperature.
 - 11. Actual mixed air temperature.
 - 12. Design outside/return air ratio.
 - 13. Actual outside/return air ratio.
- G. Duct Traverses:
- 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.
 - 9. Air temperature.
 - 10. Air correction factor.
- H. Air Terminal Unit Data:

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

I. Instrument Calibration Reports:

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

3.11 ADDITIONAL TESTS

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

END OF SECTION 23 05 93

SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.

1.2 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations. Show details for application of field-applied jackets.
- B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
- B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.
- D. Products shall be certified by UL GREENGUARD GOLD or Indoor Advantage Gold.
- E. Products shall certified to meet or exceed UL Standard 2818 -2013 Gold Standard for Chemical Emissions for Building Materials, Finishes and Furnishings
- F. Provide insulation thickness based on 2015 International Energy Conservation Code minimum requirements.
- G. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation; : www.jm.com.
 - 3. JP Lamborn Co: www.jpflex.com/#sle.
 - 4. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 5. Manson Insulation, Inc.: www.mansoninsulation.com
 - 6. Owens Corning Corp; : www.owenscorning.com.
- B. Vapor Barrier Jacket:
 - 1. FSK: Kraft paper with glass fiber scrim yard and bonded to aluminized film; 0.0032 inch vinyl.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- C. Vapor Barrier Tape:

1. Aluminized foil film, with pressure sensitive acrylic based adhesive, 3 inches wide, 6.5 mils thick, 58-ounce force/inch adhesion, 23 lbf/inch tensile strength. Service temperature -40 - 250 degree F.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville Corporation; : www.jm.com.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Manson Insulation, Inc.: www.mansoninsulation.com
 5. Owens Corning Corporation: www.ocbuildingspec.com/sle.
- B. Insulation: ASTM C 612; rigid, noncombustible board.
 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 pcf.
- C. Vapor Barrier Jacket:
 1. FSK: Kraft paper with glass fiber scrim yard and bonded to aluminized film; 0.0032 inch vinyl.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive, 3 inches wide, 6.5 mils thick, 90-ounce force/inch adhesion, 40 lbf/inch tensile strength.
- E. Indoor Vapor Barrier Finish:
 1. Manufacturers:
 - a. Fosters Model Vapor Out 30-33.
 - b. Childers Model Chil Out, CP-33.
 2. Cloth: Untreated; 9 oz/sq yd min. weight, glass fabric.
 3. Vinyl emulsion type acrylic, compatible with insulation, white color.
 4. Characteristics: 0.07 perm water-vapor permeance per ASTM E96, Procedure B at 45 mil dry film thickness; -20 degrees F to +180 degrees F temperature range; solid content, 55 percent by volume and 68 percent by weight per ASTM D 1644; white color.

2.4 DUCT LINER

- A. Manufacturers:
 1. AeroflexUSA Inc.
 2. Armacell LLC: www.armacell.us/#sle.
 3. CertainTeed Corporation: www.certainteed.com/#sle.
 4. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 5. Johns Manville: www.jm.com/#sle.
 6. Knauf Insulation: www.knaufinsulation.com/#sle.
 7. Owens Corning Corporation: www.ocbuildingspec.com/sle.
 8. RBX Corporation.
- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.

1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Fungal Resistance: No growth when tested according to ASTM G21.
4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
5. Minimum Noise Reduction Coefficients:
 - a. 1/2 inch Thickness: 0.30.
 - b. 1 inch Thickness: 0.40.
 - c. 1-1/2 inches Thickness: 0.50.
 - d. 2 inch Thickness: 0.60.
6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm when tested in accordance with ASTM C1071.
7. Connection: Waterproof vapor barrier adhesive.
8. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated Ducts Conveying Air Below Ambient Temperature:
 1. Provide insulation with vapor barrier jackets, with minimum installed R-value of 6.0.
 2. Finish with tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated Ducts Conveying Air Above Ambient Temperature:
 1. Provide with or without standard vapor barrier jacket, with minimum installed R-value of 6.0.
 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. External Duct Insulation Application:
 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 5. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

- a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - c. 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:
 - 1) 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.
 - 2) 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.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) Impale insulation over pins and attach speed washers.
 - 6) 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.
 - d. 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.
 - 1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor barrier seal.
 - 2) Install vapor stops for ductwork and plenums operating below 50 degrees 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.
 - e. 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.
 - f. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface.
 - g. 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.
6. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transition.

- c. 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:
 - 1) 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.
 - 2) 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.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) 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.
- d. 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.
 - 1) Repair punctures, tars, and penetrations with tape or mastic to maintain vapor barrier seals.
 - 2) Install vapor stops for ductwork and plenums operating below 50 degrees 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.
- e. 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.
- f. 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.

F. Duct and Plenum Liner Application:

- 1. Adhere insulation with adhesive for 100 percent coverage.
- 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
- 3. Seal and smooth joints. Seal and coat transverse joints.
- 4. Seal liner surface penetrations with adhesive.
- 5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.
- 6. Lined ducts shall be fabricated to provide the net inside dimensions shown.
- 7. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- 8. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- 9. Butt transverse joints without gaps and coat joint with adhesive.

10. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
11. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
12. Apply adhesive coating on all longitudinal seams.
13. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
14. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

3.3 DUCT INSULATION

- A. Provide insulation thickness based on 2015 International Energy Conservation Code minimum requirements.
- B. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- C. Items Not Insulated:
 1. Fibrous-glass ducts.
 2. Metal ducts and plenums with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 3. Factory-insulated flexible ducts.
 4. Factory-insulated plenums and casings.
 5. Flexible connectors.
 6. Vibration-control devices.
 7. Factory-insulated access panels and doors.

3.4 INSULATION AND JACKET SCHEDULE

- A. Duct Liner
 1. Duct liner shall not be used on the following locations:
 - a. Ahead of any coil on all air distribution systems.
 - b. Within 20 feet downstream of a humidifier.
 - c. In any supply air duct system which serves laboratory spaces or any other area having special concerns for dust or airborne contaminants.
- B. Indoor Duct and Plenum
 1. Supply Air:
 - a. Concealed, supply-air duct insulation shall be any of the following:
 - 1) Glass-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
 - b. Exposed supply-air duct insulation shall be any of the following:
 - 1) Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 2. Return Air:
 - a. Concealed, round and flat-oval return-air duct insulation shall be any of the following:

- 1) Glass-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Outdoor Duct and Plenum

1. Supply Air:

- a. Exposed, rectangular, supply-air duct insulation shall be any of the following:

- 1) Flexible Elastomeric duct liner : 2 inch thick.
- 2) Glass-Fiber Board duct liner: 3 inches thick and 2-lb/cu. ft. nominal density.

2. Return Air:

- a. Exposed, rectangular, return-air duct insulation shall be any of the following:

- 1) Flexible Elastomeric duct liner: 2 inch thick.
- 2) Glass-Fiber Board duct liner: 3 inches thick and 2-lb/cu. ft. nominal density.

END OF SECTION 23 07 13

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.

1.2 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- D. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- G. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- H. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
- I. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- J. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
- K. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- L. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
- M. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- N. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- O. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

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

- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Products shall be certified by UL GREENGUARD GOLD or Indoor Advantage Gold.
- F. Products shall certified to meet or exceed UL Standard 2818 -2013 Gold Standard for Chemical Emissions for Building Materials, Finishes and Furnishings
- G. Provide insulation thickness based on 2018 International Energy Conservation Code minimum requirements.
- H. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

2.2 GLASS FIBER, RIGID

- A. Manufacturers:
 1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville Corporation: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation: www.ocbuildingspec.com/sle.
 5. Manson Insulation.

- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
 - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
 - 1. Manufacturers:
 - a. Childers Products CP-127.
 - b. Foster Products 85-20/85-60.
 - c. Eagle Bridges - Marathon Industries, Inc.
 - 2. Shall meet ASTM C916 Type I/II
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- G. Fibrous Glass Fabric:
 - 1. Manufacturers:
 - a. Fosters Mast a Fab.
 - b. Childers Chil Glas #10.
 - 2. Cloth: Untreated; 9 oz/sq yd min. weight.
 - 3. Blanket: 1.0 pcf density.
 - 4. Weave: 5 by 5.
- H. Indoor Vapor Barrier Finish:
 - 1. Manufacturers:
 - a. Childers Products, Chil Out, CP-33.
 - b. Foster Products Vapor Out. 30-33.
 - c. Eagle Bridges - Marathon Industries, Inc.
 - 2. Cloth: Untreated; 9 oz/sq yd min. weight.
 - 3. Vinyl emulsion type acrylic, compatible with insulation, white color.
 - 4. Permeance shall be 0.07 perms or less at 45 mils dry tested by ASTM E96.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 - 2. Armacell International; Armaflex: www.armacell.com.
 - 3. K-Flex USA LLC: www.kflexusa.com/#sle.
 - 4. RBX Corp.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. K Value: ASTM C177; 0.25 at 75 degrees F.
 - 2. Minimum Service Temperature: Minus 40 degrees F.
 - 3. Maximum Service Temperature: 220 degrees F.
 - 4. Moisture Vapor Permeability:.03 perm inch, when tested in accordance with ASTM E96/E96M.
 - 5. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 ACCESSORIES

A. General Requirements:

1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
4. Supply materials that are asbestos free.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Coat all elbows, fittings, valves and flanges with vapor barrier mastic and reinforcing mesh. Finish with PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with PVC fitting covers.
- H. Inserts and Shields:
 1. Application: Insulated piping 3/4 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Shield shall span an arc of 180 degrees.
 4. Match diameter of shield to OD of insulation.
 5. Shield dimensions shall not be 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.
 - 6. Insert location: Between support shield and piping and under the finish jacket.
 - 7. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 8. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
 - 9. Steel Pipe Saddles:
 - a. Provide on all steam and steam condensate piping 3" and larger.
 - b. Provide on all heating hot water piping, operating above 200 degrees F, 3" and larger.
 - 10. Thermal-Hanger Shield Inserts: Install according to manufacturer's written instructions.
- I. Insulated Piping: Attach hangers and supports to piping as follows:
 - 1. Piping Operating Above Ambient Temperature:
 - a. Where piping is not supported on rollers or trapeze, hangers may project through insulation.
 - b. For straight runs of piping, at points of support more than 100 feet from elbow or anchor point, use roller type supports.
 - c. Where piping is supported on rollers or trapeze, support piping at outside diameter of insulation.
 - 1) NPS Smaller than 2: Provide MSS SP-58, Type 40, protective shield.
 - 2) NPS 2 1/2 and Larger: Provide thermal-hanger shield insert and weight-distribution plate.
 - 2. Piping Operating Below Ambient Temperature: Support piping at outside diameter of insulation. Do not penetrate vapor barrier.
 - a. NPS Smaller than 2: Provide MSS SP-58, Type 40, protective shield.
 - b. NPS 2 1/2 and Larger: Provide thermal-hanger shield insert and weight-distribution plate.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.

3.3 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, vessels, and equipment. 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.

3.4 INSULATION AND JACKET SCHEDULE

- A. Insulation thickness listed below is based on the thermal conductivity performance of the material listed.

1. Alternative material thickness must be adjusted as required to provide equivalent conductivity performance.
 2. Alternative material substitution shall be reviewed by the Engineer.
- B. Provide insulation thickness based on 2018 International Energy Conservation Code minimum requirements.
- C. Indoor Piping:
1. Chilled Water and Brine, Above 40 Degrees F:
 - a. 1-1/4 Inches and Smaller:
 - 1) Glass Fiber, Preformed Pipe, Type I: 1 inch thick.
 - b. 1-1/2 Inches and Larger:
 - 1) Glass Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.
 2. Heating Hot Water/Glycol Supply and Return, 200 Degrees F and below:
 - a. 1-1/4 Inches and Smaller:
 - 1) Glass Fiber, Preformed Pipe, Type I: 1 1/2 inches thick.
 - b. 1-1/2 Inches and Larger:
- D. Outdoor, Above Ground Piping, within Rooftop unit piping enclosure:
1. Chilled Water and Brine:
 - a. All Pipe Sizes:
 - 1) Flexible Elastomeric: 2" thick.
 2. Heating-Hot-Water Supply and Return, 200 Degrees F and below:
 - a. All Pipe Sizes:
 - 1) Glass-Fiber Pipe Insulation, Type I: 2 inches thick.
- E. Outdoor, Field Applied Jacket and Covers:
1. Install jacket/covers over all insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 2. Piping, Exposed:
 - a. Self-Adhering Jacketing: VentureClad, 1579CW/CE - Clear embossed.

END OF SECTION 23 07 19

SECTION 23 09 13.13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Control panels.
- B. Application Specific Controllers.
- C. Power Supplies and Transformers.
- D. Low Voltage Control Cable.
- E. Control Valves:
 - 1. Globe pattern.
 - 2. Butterfly pattern.
- F. Control Dampers.
- G. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Static pressure (air pressure) sensors.
 - 3. Equipment operation (current) sensors.
 - 4. Damper position indicators.
 - 5. Air pressure safety sensors.
- H. Thermostats:
 - 1. Outdoor reset thermostats.
 - 2. Immersion thermostats.
 - 3. Airstream thermostats.
 - 4. Electric low limit duct thermostats.
 - 5. Electric high limit duct thermostats.
- I. Transmitters:
 - 1. Building static pressure transmitters.
 - 2. Air pressure transmitters.
 - 3. Thermowells.
- J. Output Devices.
- K. Flow Sensors:
 - 1. Airflow measurement sensors (AFMS).
 - 2. Flow switches.

1.2 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. ANSI/FCI 70-2 - Control Valve Seat Leakage.
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.

- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 555S - Standard for Smoke Dampers.
- H. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- I. UL 555 - Standard for Fire Dampers.
- J. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
 1. Manufacturer's printed data sheets for all control system components clearly identify data by component.
 2. General catalog sheets, including details of construction, ratings, and dimensions for each component.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
 1. Show complete details of interconnections between temperature control systems and control specified with equipment or systems.
 2. Provide valve schedules indicating size, type, design flow, valve capacity, pressure drop and CV value, identification, and part number.
 3. Provide dampers schedule indicating dimension and descriptions of blank-offs, installation location, arrangement, velocities, static pressure drop, damper features, identification, and part number.
 4. Control panel locations indicated on plans.
 5. Clearly note the proposed deviations from specified sequences and equipment, and substantiate with written explanation.
- D. Manufacturer's Instructions: Provide for all manufactured components.
- E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- F. Project Record and Closeout Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 1. Complete Index of Contents.
 2. Revise shop drawings to reflect actual installation and operating sequences.
 3. Red-mark "Record" control system drawings and then turn them over to the Owner's Representative.
 4. Provide directions for calibration, adjustment, and maintenance instructions for each type of component.

- 5. Shop drawings of control system showing devices, interconnections between devices, and connections to items provided by others.
- 6. Specifications data sheets on each device.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience approved by manufacturer.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

1.7 MAINTENANCE SERVICE

- A. Provide service and maintenance of control system for two years from Date of Substantial Completion.
- B. Provide complete service of controls systems, including call backs. Make minimum of 8 complete normal inspections of approximately 40 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. As indicated.

2.2 EQUIPMENT - GENERAL

- A. Products Requiring Electrical and Control Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- B. All equipment provided to integrate seamlessly to the existing Trane campus wide control system.

2.3 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.
- D. Control panels shall meet the following minimum requirements:

1. Outdoors: Control panels located outdoors shall comply with NEMA 3R or 4X requirements.
 - a. Other Locations: Control panels in other locations, including but not limited to occupied spaces, above ceilings, and plenum returns shall comply with NEMA 1 requirement.
 2. Provide panels of adequate size to accommodate instruments for future expansion of approximately 25% beyond space required for this scope of work.
 3. Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.
 4. Panels mounted on vibrating equipment shall have vibration isolation protection that ensures their satisfactory operation.
- E. Local Control Panels:
1. In general, the control panels shall consist of the controller(s), display module, and I/O devices - such as relays, transducers, and so forth - that are not required to be located external to the control panel due to function. The display module shall be flush mounted in the panel face unless otherwise noted.
 2. All I/O connections on the controller shall be extended to a numbered, color-coded, and labeled terminal strip for ease of maintenance and expansion. Wiring to I/O devices shall be made from this terminal strip.
 3. All other wiring in the panel, internal and external, shall be made to additional line or low-voltage, color-coded, and labeled terminal strips. Low and line voltage wiring shall be segregated. All terminal strips and wiring shall be UL listed, 300-volt service, and provide adequate clearance for field wiring.
 4. All wiring for every control panel shall follow a common color-coded format. All terminal strip color coding and numbering shall follow a common format. All wiring shall be neatly installed in plastic trays or tie-wrapped.

2.4 APPLICATION SPECIFIC CONTROLLERS

- A. General:
1. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 2. Customized for operation within the confines of equipment served.
 3. Communication with other network devices to be based on assigned protocol.
- B. Communication:
1. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- C. Anticipated Environmental Ambient Conditions:
1. Outdoors and/or in Wet Ambient Conditions:
 - a. Mount within waterproof enclosures.
 - b. Rated for operation at 40 to 150 degrees F.
 2. Conditioned Space:
 - a. Mount within dustproof enclosures.
 - b. Rated for operation at 32 to 120 degrees F.
- D. Local Keypad and Display for each Controller:
1. Use for interrogating and editing data.
 2. System security password prevents unauthorized use.
- E. Provisions for Serviceability:
1. Diagnostic LEDs for power, communication, and processor.

2. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- F. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- G. Power and Noise Immunity:
1. Maintain operation at 90 to 110 percent of nominal voltage rating.
 2. Perform orderly shutdown below 80 percent of nominal voltage.
 3. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

2.5 POWER SUPPLIES AND TRANSFORMERS

- A. DC Power Supplies:
1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75 percent of the rated capacity of the power supply.
 2. Input: 120 VAC +10 percent, 60 Hz.
 3. Output: 24 VDC.
 4. Line Regulation: +0.05 percent for 10 percent line change.
 5. Load Regulation: +0.05 percent for 50 percent load change.
 6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
 7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
 8. A power disconnect switch shall be provided next to the power supply.
- B. Transformers and Air Terminal Unit Power:
1. Input frequency of 50/60 Hz.
 2. Internal circuit breaker.
 3. Foot Mounted
 4. Temperature range of 32 Deg. F. to 104 Deg. F.
 5. Sized to provide volts and amps as required for connected load.
 6. Input voltage shall be as required for the specific application.
 7. Transformers shall be panel mounted:
 - a. Panels located in mechanical or electrical rooms shall comply with NEMA 4 requirements.
 - b. Panels in other locations, including but not limited to occupied spaces, above ceilings, and plenum returns shall comply with NEMA 1 requirement.
 - c. Transformers and UPS can occupy the same panel enclosure.
 - d. Transformer panels cannot contain other BMCS components unless properly shielded.

2.6 LOW VOLTAGE CONTROL CABLE

- A. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable.
- B. All wiring running exposed in air plenums shall be plenum cable.
- C. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC, and General Purpose Cabling:
1. Cable shall consist of copper conductors not less than #18 AWG stranded.
 2. Cable shall be two- or three-conductor twisted cable with a drain wire.
 3. Cable shall have a 100 percent overall shield.
 4. Cable shall be plenum rated.

5. Cable shall meet or exceed NEC voltage rating of 300 volts.
 6. Cable shall be NEC type CMP.
 7. Cable shall meet or exceed UL temperature rating of +60 deg C.
 8. Cable shall be labeled at a minimum of every 18 inches with the DDC system manufacturer's name and the type of signal carried within the cable, i.e., analog input, analog output, binary input, binary output, 24 VAC.
- D. Primary and Secondary Communications Network Cabling:
1. Cable shall be of type recommended by the DDC system manufacturer.
 2. Cable shall be shielded.
 3. Cable shall be plenum rated.
 4. Cable shall meet or exceed NEC voltage rating of 150 volts.
 5. Cable shall meet or exceed UL temperature rating of +60 deg C.

2.7 CONTROL VALVES

- A. Control Valve General Requirements:
1. Valve Assembly: Provide commercial-grade valve type unless otherwise indicated.
 2. Identification Tag: Custom octagon type, brass, engraved.
 - a. Information: Show Cv with fail setting.
 - b. Fastened: Beaded chain, brass.
 3. Valve Selection:
 - a. Flow Characteristic:
 - 1) Equal Percentage: Water, brine and liquid service.
 - 2) Linear: Steam service.
 - b. Sizing:
 - 1) Pipe Line Size: Use for 2-position (open/close) and solenoid types.
 - 2) Cv (Valve Coefficient): Size using expected load flow and pressure drop across branch which includes coil, pipe, and fittings.
- B. Ball Valves:
1. Service: Use for brine (30 percent glycol), chilled water, or hot water.
 2. Flow Characteristic: Include 2-way operation configured to fail normally closed (NC).
 3. Replacements in Kind: Provide pressure-independent type.
 4. Rangeability: 500 to 1.
 5. ANSI Rating: Class 150.
 6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
 7. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - a) Body: Brass.
 - b) Flanges: Ductile iron.
 - c) Ball: Chrome-plated brass.
 - d) Stem: Nickel-plated brass.
 - e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - f) Stem Seal: EPDM O-Rings.
 - g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches and Above:
 - 1) Connection Type: Flanged.

- 2) Materials:
 - a) Body: Brass.
 - b) Flanges: Ductile iron.
 - c) Ball: 300 series stainless steel.
 - d) Stem: 300 series stainless steel.
 - e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - f) Stem Seal: EPDM O-Rings.
 - g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F.
- C. Globe Pattern:
- 1. Service: Use for brine (30 percent glycol), chilled water, hot water, or steam.
 - 2. Flow Characteristic: Include 2-way operation configured to fail normally open (NO).
 - 3. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - a) Body: Cast bronze.
 - b) Bonnet: Brass.
 - c) Stem: Stainless steel.
 - d) Plug: Brass.
 - e) Seat: Brass against elastomeric disk.
 - f) Packing: Self-adjusting ethylene propylene rubber (EPR) ring pack u-cups.
 - 3) Rangeability: Five to one.
 - 4) Leakage: Class III per ANSI/FCI 70-2.
 - 5) Maximum Pressure Differential: 25 psig.
 - 6) Service Temperature:
 - a) Fluid Side: Standard, 32 to 200 degrees F (0 to 93 degrees C).
 - b) Ambient Side: 32 to 104 degrees F.
 - b. 2-1/2 inches and Above:
 - 1) Connection: Flanged.
 - 2) Materials:
 - a) Body: Cast Iron with black lacquer finish.
 - b) Stem: 316 or 303 stainless steel.
 - c) Trim: Bronze (chilled, hot water, and brines).
 - d) Plug: Brass packing, ethylene propylene terpolymer (EPT) ring packs.
 - e) Packing: EPDM o-ring (chilled, hot water, and brines).
 - 3) Rangeability: 100 to one.
 - 4) Maximum Pressure Differential: 25 psig.
 - 5) Leakage: Class III per ANSI/FCI 70-2.
 - 6) ANSI Rating: Class 125 per ASME B16.1
 - 7) Service Temperature:
 - a) Fluid Side: High temp, 32 to 250 degrees F (0 to 121 degrees C) liquid or 15 psig (103.4 kPa) steam.
 - b) Ambient Side: 32 to 104 degrees F.
- D. Butterfly Pattern:

1. Service: Use for brine (30 percent glycol), chilled water, condenser water, or hot water.
2. Flow Characteristic: 2-way operation configured to fail normally closed (NC).
3. Connection Type: Flanged.
4. Rangeability: 10 to 1 between the 30 to 70 degrees F range.
5. Maximum Fluid Velocity: 12 feet/sec.
6. Leakage Rating: Bubble-tight at rated maximum differential pressure.
7. ANSI Rating: Class 250 per ASME B16.1
8. Size: 12 to 20 inches.
9. Materials:
 - a. Body: Cast iron.
 - b. Disc: 304 stainless steel.
 - c. Seat: EPDM (ethylene propylene diene monomer), peroxide-cured.
 - d. Stem: 416 stainless steel.
 - e. Tee: Ductile iron (3-way valves only).
10. Service Temperature:
 - a. Fluid Side: Minus 40 to 250 degrees F liquid or 15 psig steam.
 - b. Ambient Side: Minus 22 to 122 degrees F.

2.8 CONTROL DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
 1. Dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required.
 2. Dampers used for mixing of airstreams (OA & RA) shall be parallel blade type arranged for mixing, with blades directing the airstreams together.
 3. Multiple section dampers may be jack shafted to allow mounting of actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.
 4. Airfoil blade dampers of double-skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 fpm or system pressure exceeds 2.5 inches w.c., but no more than 4000 fpm or 6 inches w.c.
- D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
- G. Linkage Bearings: Oil impregnated sintered bronze.
- H. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.
- I. Maximum Pressure Differential: 6 inches wg.
- J. Temperature Limits: Minus 40 to 200 degrees F.
- K. Blade Position Switch:
 1. Type: Damper-blade attached lever.

2.9 ELECTRIC VALVE AND DAMPER ACTUATORS

- A. Manufacturers:
 - 1. Belimo Aircontrols (USA), Inc: www.belimo.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. Schneider Electric: www.schneider-electric.us/#sle.
- B. General Requirements:
 - 1. Assembly: Products field-installed onto dampers and valves.
 - 2. Actuator Capacity: Next torque size above calculated load requirement for single units. Increase selected capacity by 25 percent when multiple units are required.
 - a. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
 - b. Spring return, as indicated, with auxiliary end switch and minimum position potentiometer.
 - 1) For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator. Non-mechanical forms of fail-safe operation are not acceptable.
 - c. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have a manual crank for this purpose.
 - 3. Fire Protection Systems:
 - a. Smoke Control: UL 2043 tested, listed, and labeled for use with UL 555S listed dampers.
 - b. Fire-Smoke Control: UL 2043 tested, listed, and labeled for use with dampers complying with UL 555 and UL 555S.
 - c. Run Time: 60 second travel with a 20 second spring return on a 250 degrees F (121 degrees C) rated damper.
 - d. External Reset Switch: Key-operated type interfaced with fire protection device or system installed next to damper section at 48 inches above finished floor.
 - 4. Environmental Operating Range:
 - a. Temperature: From minus 22 to 122 degrees F.
 - b. Humidity: 5 to 90 percent RH (non-condensing).
 - 5. Manual Operators:
 - a. Provide latching operator per actuator.
 - b. Operator Type: Hand quadrant lever.
- C. Valve Actuators:
 - 1. Select operator for full shut off at maximum pump differential pressure.
 - 2. Size for torque required for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
 - 3. Terminal unit reheat coil control valves be proportional 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.
 - 4. Fail-Safe Operation: Mechanical, spring-return mechanism.
 - a. Control Valve Normal Fail-Safe position:
 - 1) AHU heating coil: NO
 - 2) AHU cooling coil: NC
- D. Damper Actuators:

1. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - b. Provide one operator for maximum 36 sq ft damper section.
 2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
 3. Fail-Safe Operation: Mechanical, spring-return mechanism.
 - a. Damper Normal Fail-Safe position:
 - 1) Outdoor Air: NC
 - 2) Return Air: NO
 - 3) Relief Air: NC
- E. Mechanical Configuration:
1. On/Off or 2-Position:
 - a. Input: 24 VAC.
 - b. Power: 24 VAC.
 - c. Position Feedback: Dry contact.
 - d. Stroke Duration: 60 seconds, adjustable.
 - e. Fail Safe Control: Spring-return.
 2. Floating or Three-Position:
 - a. Input: Dual, 24 VAC.
 - b. Power: 24 VAC.
 - c. Position Feedback: Dry contacts, (open-closed status).
 - d. Stroke Duration: 90 seconds, adjustable.
 - e. Fail Safe Control: Spring-return.
 3. Proportional (Modulated):
 - a. Input: 0 to 10 VDC.
 - b. External Power: 24 VDC.
 - c. Position Feedback: 0 to 10 VDC.
 - d. Stroke Duration: 60 seconds.
 - e. Type: Maintenance-free brushless DC Motor.
 - f. Fail Safe Control: Built-in energy storage, return under 20 seconds.
 - g. Adjustable Settings: Stroke direction, zero, span, and offset.
- F. Angle of Rotation: 95-degree, adjustable range with mechanical end stop.
- G. Motor Direction: Clock wise (CW) counter-clock wise (CCW) selectable.
- H. Position Indicator: Scale indicator with tracking pointer.
- I. Overload Protection Type: Electronic.
- J. Electrical Protection: Double-insulated.
- K. Enclosure Rating: Listed as complying with NEMA 250 and UL 50 or UL 50E use in non-hazardous locations such as:
 1. Indoors and Plenums: NEMA 250, Type 1.
 2. Mechanical Rooms: NEMA 250, Type 2, using any mounting orientation.
 3. Outdoors: NEMA 250, Type 4 or Type 4X with built-in heaters for extreme ambient conditions.
- L. Provide the following features and accessories where indicated or where required to complete installation:
 1. Auxiliary switches (SPST).

2. Battery backup.
3. Conduit connector.
4. Gaskets.
5. Potentiometer interface.
6. Pulse-width modulation (PWM) interface.
7. Resistor kit.
8. Terminal strip.
9. Thermal sensors.
10. Transformer.

2.10 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 4. Temperature Sensing Device: Compatible with project DDC controllers.
 5. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Range: Minus 25 degrees F through 122 degrees F minimum.
 - 3) Heat Dissipation Constant: 2.7 mW per degree C.
 - c. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
 - d. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 - 3) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
 - e. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 - f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - 1) Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - 2) Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

- g. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - h. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.
 - i. Room Temperature Sensors:
 - 1) Construct for surface or wall box mounting.
 - 2) Provide the following:
 - a) Setpoint reset slide switch with an adjustable temperature range.
 - b) Individual heating/cooling setpoint slide switches.
 - c) Momentary override request push button for activation of after-hours operation.
 - d) Analog thermometer.
 - j. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft or larger.
 - 2) Use averaging elements where prone to stratification with sensor length 8 ft, or 16 ft.
 - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
 - k. Insertion Elements:
 - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - 2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Humidity Sensors:
- 1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
 - a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
 - b. Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.
 - c. Output Voltage Type: 3-wire observed polarity.
 - d. Output mA Type: 2-wire, not polarity sensitive (clipped and capped).
 - e. Humidity:
 - 1) HS Element: Digitally profiled thin-film capacitive.
 - 2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multi-point calibration, NIST traceable.
 - a) Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
 - 3) Scaling: 0 to 100 percent RH.
 - f. Temperature Effect:
 - 1) Duct Mounted: Plus/minus 0.18 percent per degree F.
 - 2) Outdoor Mounted: 4 to 20mA version: $(0.0013 \times \%RH \times (T_{\text{degreeC}} - 25))$.
 - g. Hysteresis: 1.5 percent typical.
 - h. Linearity: Included in accuracy specification.
 - i. Reset Rate: 24 hours.
 - j. Stability: Plus/minus 1 percent at 68 degrees F (20 degrees C) annually, for two years.
 - k. Temperature Monitoring:
 - 1) Temperature Transmitter Output: Digital, 4 to 20mA (clipped and capped) or 0-5V/0-10V output.
 - a) HO Transmitter Accuracy: Plus/minus 2.3 degrees F.
 - b) HD Transmitter Accuracy: Plus/minus 1.0 degree F.

- I. Operating Environment:
 - 1) Operating Humidity Range: 0 to 100 percent RH noncondensing.
 - 2) Operating Temperature Range: Minus 40 degrees F to 122 degrees F.
- 2. Wall Mounted Sensor: Voltage type encased in a plastic housing.
- C. Static Pressure (Air Pressure) Sensors:
 - 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 - 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 4. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- D. Equipment Operation (Current) Sensors:
 - 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
 - 2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
 - 3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- E. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.
- F. Air Pressure Safety Sensor:
 - 1. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for two amps at 120 VAC.
 - 2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

2.11 THERMOSTATS

- A. Outdoor Reset Thermostats:
 - 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
 - 2. Scale range: Minus 10 to 70 degrees F.
- B. Immersion Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- C. Airstream Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 - 2. Averaging service remote bulb element: 7.5 feet.
- D. Electric Low Limit Duct Thermostats:
 - 1. 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 setpoint,
 - 2. Bulb length: Minimum 20 feet.
 - 3. Provide one thermostat for every 20 sq ft of coil surface.
 - 4. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

- E. Electric High Limit Duct Thermostats:
 1. 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 setpoint,
 2. Bulb length: Minimum 20 feet.
 3. Provide one thermostat for every 20 sq ft of coil surface.
 4. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

2.12 TRANSMITTERS

- A. Building Static Pressure Transmitters:
 1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.
- B. Air Pressure Transmitters:
 1. General: Provide dry media differential pressure transducers to monitor duct and room pressure.
 - a. Media Compatibility: Dry air.
 - b. Input Power: Class 2; 12 to 30 VDC; 2-wire: 20 mA max.
 - c. Output: Field selectable, 2-wire, loop-powered 4 to 20 mA (DC only, clipped and capped).
 - d. Pressure Ranges: 4 and 7, field selectable.
 - e. Response Time:
 - 1) Standard: T95 in 20 seconds.
 - 2) Fast: T95 in 2 seconds.
 - 3) Switch selectable.
 - f. Mode: Switch selectable, unidirectional.
 - g. Display:
 - 1) Signed 3-1/2 digit LCD, indicates pressure.
 - 2) Over-range indicator.
 - h. Proof Pressure (pressure differential): 3 psid.
 - i. Burst Pressure (pressure differential): 5 psid.
 - j. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).
 - k. Temperature Effect (per transmitter size):
 - 1) 1 inch w.c.: 2.0 percent per degree C.
 - 2) 10 inch w.c.: 0.01 percent per degree C.; (Relative to 25 degrees C) 32 degrees F to 122 degrees F.
 - l. Zero Drift (1-year) (per transmitter size):
 - 1) 1 inch w.c.: 2 percent maximum.
 - 2) 10 inch: 0.05 percent maximum.
 - m. Zero adjust: Pushbutton auto-zero and digital input (2-pos terminal block).
 - n. Operating Environment:
 - 1) 32 degrees F to 140 degrees F.
 - 2) 0 to 90 percent RH noncondensing.
 - o. Fittings:
 - 1) Brass barb.
 - 2) 0.24 inches outer diameter.
 - 3) UL 94 V-O fire retardant ABS.
- C. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):

1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow remote pressure sensing capability using existing plumbing runs.
 - a. Input Power: Class 2; 15 to 30 VDC, 24VAC nominal, 50/60 Hz.
 - b. Maximum Current Draw:
 - 1) DC: 125 mA.
 - 2) AC: 280 mA.
 - c. Output: 3-wire transmitter; user-selectable, 4 to 20 mA (0 to 5V/0 to 10V).
 - d. Sensor:
 - 1) Media Compatibility: 17 to 4 PH stainless steel.
 - 2) Status Indication: Dual color LED.
 - 3) Proof Pressure: 2x max. F.S. range.
 - 4) Burst Pressure: 5x max. F.S. range.
 - 5) Accuracy at 77 degrees F for less than or equal 20 ft:
 - a) Ranges A and B: Plus/minus 1 percent F.S. typical.
 - b) Range C: Plus/minus 1.5 percent F.S. typical.
 - c) Range D: Plus/minus 2 percent F.S. typical.
 - 6) Surge Damping: Electronic; 1 second averaging.
 - 7) Long Term Stability: Plus/minus 0.25 percent.
 - 8) Zero Offset (Bidirectional and Port Swap Modes Only): 0.5 percent.
 - e. Reverser:
 - 1) Zero Adjust: Push button auto-zero and digital input (2-position terminal block).
 - 2) Fittings:
 - a) 27 NPT female thread, stainless steel 17 to 4 PH.
 - f. Pressure Ranges:
 - 1) 0 psi to 50 psi (Gauge): 5 psid/10 psid/25 psid/50 psid (pressure differential).
 - 2) 0 psi to 100 psi (Gauge): 10 psid/20 psid/50 psid/100 psid (pressure differential).
 - 3) 0 psi to 250 psi (Gauge): 25 psid/50 psid/125 psid/250 psid (pressure differential).
 - g. Operating Conditions:
 - 1) Temperature Compensated Range:
 - a) 32 degrees F.
 - b) TC Zero less than 1.5 percent of product F.S. (full scale) per sensor.
 - c) TC Span less than 1.5 percent of product F.S. (full scale) per sensor.
 - 2) Sensor Operating Range: Minus 4 degrees F to 185 degrees F.
 - 3) Operating Environment: 14 degrees F to 122 degrees F; 10 to 90 percent RH noncondensing.
 - h. Enclosure: NEMA 250, Type 4.
 - i. Bypass manifold or 3-valve manifold for service and commissioning.
- D. Thermowells:
 1. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and Greenfield fitting.
 2. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
 3. Thermowells and sensors shall be mounted in a threadolet or 1/2-inch NPT saddle and allow easy access to the sensor for repair or replacement.

4. Thermowells shall be constructed of brass.

2.13 OUTPUT DEVICES

A. Control Relays:

1. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
2. Mounting bases shall be snap mount.
3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
4. Contacts shall be rated for 10 amps at 120 VAC.
5. Relays shall have an integral indicator light and check button.

2.14 FLOW SENSORS

A. Airflow Measurement Sensor (AFMS):

1. Manufacturers:
 - a. Air Monitor.
 - b. Ebtron.
 - c. Ruskin.
2. Airflow Straighteners:
 - a. Provide AFMSs with an airflow straightener if required by the AFMS manufacturer's published installation instructions.
 - b. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMS.
 - c. Straightener: Contained inside a flanged sheet metal casing, with the AFMS located as specified according to the published recommendations of the AFMS manufacturer.
 - d. Construction to consist of 0.125 inch aluminum honeycomb with the straightener depth not less than 1.5 inches.
3. Outdoor Air Temperature: In outside air measurement or in low-temperature air delivery applications, provide an AFMS certified by the manufacturer to be accurate as specified over a temperature range of minus 20 degrees F to 120 degrees F.
4. Airflow Resistance:
 - a. Resistance to Airflow Through the AFMS and the Airflow Straightener: Not to exceed 0.085 inches at an airflow velocity of 2000 fpm.
 - b. AFMS Construction: Suitable for operation at air flows of up to 5000 fpm over a temperature range of 40 degrees F to 120 degrees F.
5. Pitot Tube:
 - a. Furnish each pitot tube AFMS with an array of velocity sensing elements.
 - b. Velocity Sensing Elements: Multiple pitot tube type with averaging manifolds.
 - c. Distribute the sensing elements across the duct section in the pattern and quantity specified or as recommended by the installation instructions of the AMFA manufacturer.
 - 1) Pitot Tube AFMSs in Air Flows Over 600 fpm: Accuracy of plus/minus 5 percent over a range of 500 fpm to 2500 fpm.
 - 2) Pitot Tube AFMSs in Air Flows Under 600 fpm: Accuracy of plus/minus 5 percent over a range of 125 fpm to 2500 fpm.
6. Electronic:
 - a. Each electronic AFMS to consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type.

- b. Sensing Elements: Distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the manufacturer.
 - c. Electronic AFMS's: Accuracy of plus/minus 5 percent over a range of 125 fpm to 5,000 fpm and temperature compensated output over a range of 32 degrees F to 212 degrees F.
 - d. Fan Inlet Measurement Devices: Refer to Drawings and/or Equipment Schedules.
- B. Flow Switches:
- 1. Repetitive Accuracy: Plus/minus 10 percent of actual flow setting.
 - 2. Switch Actuation: Adjustable over the operating range and sized for the application, such that the setpoint is between 25 and 75 percent of the full range.
 - 3. Provide Form C snap-action contacts, rated for the application.
 - 4. Furnish non-flexible paddle with magnetically actuated contacts, rated for service at a pressure greater than the installed conditions.
 - 5. Flow Switch for Use in Sewage Systems: Rated for use in corrosive environments encountered.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches and humidistats. Refer to Section 26 27 26.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Provide guards on thermostats in entrances.
- G. Provide insulated mounting bases on thermostats and other temperature sensing devices in the following locations:

1. Exterior walls.
 2. Masonry/CMU walls.
 3. Interior walls that back up to mechanical/utility rooms and other non-conditioned spaces.
- H. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- I. Provide Energy Valves where indicated.
- J. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.
- K. Provide isolation (two position) dampers of parallel blade construction.
- L. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- M. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- N. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- O. Provide boxes, conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
1. Provide boxes and conduit pathways (to ceiling spaces), for all wall mounted thermostats and sensors and wiring. Refer to Division 26.

3.3 CONTROL PANELS

- A. Control panel for each system where more than one control device requires field mounting, (air handling units, exhaust fans, miscellaneous control systems including pump controls, heat exchanger controls, etc.). Single devices may be mounted on piping, wall or ductwork. Install local control panel where indicated on Drawings or suitable location adjacent to system served.
- B. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 6 ft above floor. Install panels so front cover door can swing fully open without interference.
- C. Panels mounted on vibrating equipment shall have vibration isolation protection that ensures their satisfactory operation.
- D. All control panels located in accessible areas be provided with keyed locks. Locks shall utilize a single master key. Provide 2 spare key sets to Owner.
- E. Panel Layout:
1. Locate controllers in lower half of panel first and upper half second.
 2. Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6' above finished floor.
 3. Separate 24 VDC and 120 VAC, wire, cable, and devices by 6" minimum space.
 4. Enclose wire and cable in wireways or bundle w/ wire ties and secure to back-panel. This does not apply to wire exiting wireways to terminal strips or panel mounted devices.

5. Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.

3.4 SENSORS AND INPUT/OUTPUT DEVICES

- A. All input and output devices shall be installed per the manufacturer's recommendation.
- B. Building Differential Air Pressure Applications: Transmitter's exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
 1. Unless indicated otherwise, locate the exterior sensing tip near the building's main entrance.
 2. The interior sensing tip shall be inconspicuous and located within a central corridor on the same level as the entrance.
- C. Outside Air Humidity Sensors: Outside air relative humidity sensors shall be installed with a rain-proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with seal-tight fittings and stainless steel bushings.
- D. Outside Air Sensors: Outside air sensors shall be mounted on the north wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air temperatures accurately. Sensors exposed to solar radiation must be installed with solar shields. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.
- E. Water Pressure Sensors: Install water pressure sensors and differential pressure sensors with three-valve by-pass and pressure test ports for use in calibration and testing.
- F. Low Temperature Limit Switches: Mount element horizontally across duct in a serpentine pattern ensuring each square foot of coil is protected by one foot of sensor. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
- G. Duct Mount Sensors:
 1. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
 2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3.5 ELECTRICAL WIRING

- A. Install wiring in accordance with National Electric Code, ANSI/NFPA 70.
- B. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable. All wiring running exposed in air plenums shall be plenum cable.
- C. Install wiring (low and line voltage) in metal raceways or conduit unless inside control cabinet or unit enclosures. For concealed and accessible areas, plenum-rated wiring and cabling may be used.
- D. Class 2 wiring not installed in conduit shall be supported every five feet from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.

- E. Low voltage control wiring and 24 VAC can be run in the same conduit. Power wiring 120 VAC and greater must be in a separate conduit.
- F. Fastening shall be secured to walls or ceilings by means of appropriate screws, expansion screws anchors, toggle bolts, hollow wall screw anchors, nylon expansion anchors, or expansion shields. All-purpose plastic anchors are not acceptable.
- G. Locate circuits, relays, transformers, or other equipment that contains or must be connected to voltages exceeding 130 volts, in separate cabinets, which may be adjacent to control panels; permanently label "DANGER 277 VOLTS" or appropriate volts.
- H. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size shall be 3/4 inch.

3.6 CONTROL WIRING AND POWER CONNECTIONS

- A. Provide all incidental control power and wiring required to make the equipment or systems fully operational. Coordinate with equipment manufacture incidental wiring requirements.
- B. Unless indicted elsewhere, provide line voltage, 120VAC, 20 amp dedicated control power circuits and LAN outlet to each of the following and as indicated:
 1. BMCS Control panel, 1 circuit.
 2. Air handling Unit, 1 circuit.
 3. Air Terminal Unit Power supply transformer panel, 1 circuit per 20 terminal units. Each double duct terminal utilizes two terminal units.
 4. DDC Power supply and transformer panel. 1 circuit can power 30 terminal units.
 5. Coordinate required 120V power circuits and LAN outlets with Electrical Contractor.
- C. Incidental control wiring includes but not limited to:
 1. Air Handling Units:
 - a. Fans
 - b. Damper Operators
 - c. Lights
 - d. Valve Operators
 2. Equipment Motors Starters
 3. HVAC Controls (Including but not limited to):
 - a. Manufacturer's Packaged Control Systems
 - b. Control Relays
 - c. Air Terminal Units
 - d. Control Dampers and Valves
 - e. Temperature, Flow and Occupancy Sensors
 - f. Current Sensors
 - g. Transmitters
 4. Remote Monitoring and Control Panels (Provided by Equipment Manufacturers)
 5. Smoke Dampers at Air Handling Units
 6. Supply, Return and Exhaust Fans
 7. Unit Mounted Motor Starters, Contactors, Disconnect Switches, Thermal Overloads and Heaters
 8. Variable Frequency Controls.

3.7 START-UP SERVICES

- A. Verify proper location of each device and point-to-point system integrity. Correct as needed.

- B. When installation is complete and automatic control system is placed in operation, adjust and calibrate all instruments and devices in system and ensure that system is operating in accord with specified sequences.
- C. Diagnose component and system problems. Communicate irregularities to the appropriate contractor for correction.
- D. Attend construction meetings as required to coordinate with other contractors and provide input during problem resolution.

3.8 IDENTIFICATION STANDARDS

- A. If the owner utilizes a specific equipment or system identification or naming convention, the contractor shall use for all systems, nameplates and equipment references in all project documentation.
- B. Field Devices: All field devices shall be identified by a typed (not handwritten) securely attached tag label.
- C. Controller Identification: All controllers shall be identified by typed (not handwritten) securely attached tag label.
- D. Panel Identification: All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
- E. Panel Devices: All panel devices shall be identified by a typed label securely fastened to the back plate of the local control panel.
- F. Raceway Identification: All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not handwritten.
- G. Wire Identification: All low and line voltage control wiring shall be identified by a number or name, as referenced to the associated control diagram, at each end of the conductor cable. Identification number or name shall be permanently secured to the conductor or cable and shall be typed.

3.9 TRAINING

- A. Provide demonstration and training in accordance with Section 01 7900 - Demonstration and Training.

END OF SECTION 23 09 13.13

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System description.
- B. Controllers.
- C. Power supplies and line filtering.
- D. System software.
- E. Controller software.
- F. HVAC control programs.

1.2 REFERENCE STANDARDS

- A. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.
- B. NFPA 70 - National Electrical Code.
- C. UL (DIR) - Online Certifications Directory.

1.3 DEFINITIONS

- A. BMCS: The complete building management and direct-digital control (DDC) system described in this specification section, Trane SC.
- B. Provide: Furnish, install, commission, test, and warrant.
- C. Furnish: Purchase and deliver to the appropriate installing Contractor, complete with every appurtenance, document, commission, and warranty.

1.4 CONTROL SYSTEM INTERFACES

- A. The Building automation controls system shall be an extension of the existing Trane Building Automation System, no exceptions. System shall fully support the controls environment and be able to interface and integrate third party systems via vendor BACnet protocol.
- B. The BMCS contractor shall coordinate with all contractors and the associated manufacturers responsible for the systems and shall determine the points that are to be mapped from the BMCS to the third party system and the points that are to be mapped from the third party system to the BMCS.
- C. Control Interface Coordination Meeting(s):
 - 1. The BMCS contractor shall meet with the contractors, equipment suppliers, manufacturers, etc. furnishing the equipment to coordinate information details and functions between the equipment and BMCS. Each contractor/supplier shall provide complete details of the proposed interface including the PICS (Protocol Implementation Conformance Statement) for BACnet equipment, hardware and software identifiers, wiring requirements, communication speeds and required network accessories.

2. The purpose of this meeting is to insure that there are no unresolved issues regarding the integration of equipment into the existing Trane BMCS network and final coordination of all Sequences of Operation.
 3. The meeting(s) shall include the Owner's Representative.
 4. Submittals for this equipment will not be reviewed prior to the completion of these meetings.
- D. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
1. Variable Frequency Controllers.
 2. Air-Handling Units.
 3. Double Duct Terminal Units
- E. Where it is possible to map points from one system to the other that are not identified in these Contract Documents, the BMCS contractor shall advise the Owner, Consultant, and Engineer; and they shall determine whether additional points are to be mapped from one system to the other.
- F. Provide mapping, alarm configuration, and graphic creation of, at minimum, twice the listed point quantities within these documents and as directed by the Owner.
- G. The BMCS contractor shall provide details of the method of integration and the information to be transferred between the systems as part of the shop drawing package.
- H. Equipment manufacturer/contractor shall provide communication port specifically for the interfacing of the system to the BMCS.
- I. The BMCS contractor shall be responsible for all cable, conduit, and suitable cable connectors to the port on the system and the BMCS and other components as necessary for the software communications link from the system to the BMCS.
- J. The fact that the points are mapped from systems to the BMCS shall be transparent to the operator. It shall not be necessary for the BMCS operator to know that the points are mapped from another system in order to implement such functions as adding and deleting a mapped point on a report/graphic, adjusting schedules and alarm limits associated with a mapped point, including a mapped point in a sequence of operations, etc.
- K. If the BMCS contractor cannot document that the exact same interface has been performed between the BMCS and the systems, then the interfaces shall be tested prior to installations at an offsite location. If the test is successful, the BMCS contractor shall advise the Owner and Engineer and a time shall be established that is acceptable to the Owner and Engineer when the interface can be demonstrated.
- L. The BMCS hardware shall not be installed at the project location until all system interfaces to the BMCS have been successfully demonstrated or documented.
- M. Contractor shall be responsible for providing all equipment necessary to perform the demonstration and for ensuring the presence at the testing of suitably skilled personnel from system manufacturer/contractor. The testing of the interface between the two systems shall verify, at minimum, that:
1. All data points mapped from the system to the BMCS are displayed correctly on the BMCS monitor and have the same functionality as points directly monitored/controlled by the BMCS.
 2. All data points mapped from the BMCS to the system are displayed correctly on the systems monitor.
 3. All mapped points are identical with regard to value, engineering units, and significant digits on both systems.

4. All points mapped from the system to the BMCS meet all of the specifications detailed in the contract documents for points directly monitored/controlled by the BMCS.
 5. The communications watchdog is functioning correctly.
 6. Communications speed between the two systems is satisfactory.
 7. Both systems restart and communications between the two systems resume following a power failure without operator intervention.
- N. Site tests similar to those detailed above shall be repeated as part of the final acceptance testing.
- O. Documentation regarding the BMCS software interfaces shall be provided in sufficient detail as to enable a person reasonably skilled in the writing of real time software applications to add/delete points mapped from one system to the other. At minimum, the documentation shall include a detailed description of each protocol used and the model, version, and firmware details of any protocol converter (gateway) that is used.
- P. A watchdog procedure must be implemented that enables the identification of the point of failure, i.e., where in the communications chain between the two systems did the failure occur. The watchdog function must operate at a frequency that detects a failure within 60 seconds.

1.5 SUBMITTALS

- A. Specification Compliance Review.
- B. Shop drawings and product data shall be in original searchable PDF format.
- C. Product data shall be presented according to an included table of contents.
- D. Product Data: Provide data for each system component and software module.
- E. Shop Drawings:
1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 2. List connected data points, including connected control unit and input device.
 3. All components and controllers inclusive or 3rd party shall have a points list for each. Deviation from contract documents shall be reported to design team with alternates and/or a reason for deviation.
 4. Control drawings shall have a completed system architecture. Controllers and components inclusive to the control system as well as 3rd party controllers and components to be integrated and/or communicated with.
 5. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 6. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 7. Indicate description and sequence of operation of operating, user, and application software.
- F. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- G. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Include submittals data in final "Record Documents" form.

3. All wiring pathways, connections, junctions, transformers, etc. shall be as-built of a floor plan drawings and included with record drawings.
- H. Operation and Maintenance Data:
1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.
- E. Comply with ASHRAE 135 for DDC system control components. BTL listed.
- F. Security Standards and Reference Guides:
 1. Transport Layer Security (TLS) TLS 1.2
 2. Enviromental Security Technology Certification Program (ESTCP) Cybersecurity Guidelines

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.8 CONTRACTOR QUALIFICATIONS

- A. The BMCS contractor shall:
 1. Have a local staff in the area of trained personnel capable of giving instructions and providing routine and emergency maintenance on the BMCS, all components and software/firmware, and all other elements of the BMCS.
 2. Have comprehensive local service and support facilities for the total BMCS as provided.
 3. Maintain local, or have approved local contracted access to, supplies of essential expendable parts.

1.9 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.

1.10 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Trane: www.trane.com

2.2 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume double duct terminals, reheat coils, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- G. BMCS Contractor shall be responsible for all electrical work associated with the BMCS.
 - 1. Perform all wiring in accordance with all local and national codes.
 - 2. Install all line voltage wiring, concealed or exposed, in conduit in accordance with the division 26 specifications, NEC and local building code.
 - 3. Provide extension of 120 volt, 20 amp circuits and circuit breakers from Emergency power panels for all BMCS equipment, transformers and panel power. Provide and install local UPS Power supply for all BMCS system panels and equipment.
 - 4. Surge transient protection shall be incorporated in design of system to protect electrical components in all BMCS Controllers and operator's workstations.
 - 5. All low voltage electrical control wiring throughout the building whether in exposed areas shall be run in conduit in accordance with the division 26 specifications, local building code and the NEC.
 - 6. Provide all miscellaneous field device mounting and interconnecting wiring for all mechanical systems including fuel oil system, emergency generators, chillers, water treatment, AC units, condensing units, expansion tanks, VFD, unit heaters, filtration systems, terminal units, fan coil units, electric heater's, chiller control system.

7. All systems requiring interlock wiring shall be hardwired interlocked and shall not rely on the BMCS to operate (e.g. emergency generator to fuel oil pump interlock, emergency generator damper interlock, etc.) Interlock wiring shall be run in separate conduits from BMCS associated wiring.

2.3 CONTROLLERS AND PANELS

- A. Primary DDC panels as follows:
 1. Minimum one (1) BMCS system Primary DDC panel per floor. The application specific controllers installed for the terminal units on a floor will be connected to the BMCS panel on the same floor.
 2. Minimum one (1) BMCS system Primary DDC panel per each major mechanical system:
 - a. Air Handling Unit
 3. It is acceptable to wire the following systems into any of the Primary DDC panels:
 - a. Miscellaneous alarm monitoring (i.e. ATS, leak, temperature, light ...etc.)
 - b. Miscellaneous equipment (i.e. Unit Heater, Domestic Water Heater, Standalone Dampers ...etc.)
 4. Motors in motor control centers shall be controlled from the DDC controller associated with HVAC system. It shall not be acceptable to control all motors in a MCC from one DDC controller dedicated to the MCC. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
- B. Building Controllers
 1. General:
 - a. All controllers must be of open protocol.
 - b. Controls shall be BTL listed.
 - c. All controllers must be Niagara based of the latest firmware with open license provided to owner for future warranty and service.
 - 1) Provide administrator level username and password for owner so that they may access administrator level functions and configurations.
 - 2) Provide administrator level username and password for any contractor via the owner so that they may access administrator level functions and configurations.
 - 3) Provide audit trail for any administrator level user to provide the owner and initial installing contractor a history of changes for security and liability. This shall be at the discretion of the installing contractor during the warranty period.
 - d. All binary/digital outputs must have LED status.
 - e. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - f. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - g. Share data between networked controllers.
 - h. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - i. Utilize real-time clock for scheduling.
 - j. Continuously check processor status and memory circuits for abnormal operation.
 - k. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

- l. Communication with other network devices to be based on assigned protocol.
 - m. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required.
 - n. Provide control unit's with minimum 30 percent spare capacity.
 - o. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
 - p. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.
 - q. Controller perform in stand-alone mode:
 - 1) Start/stop.
 - 2) Duty cycling.
 - 3) Automatic Temperature Control.
 - 4) Demand control via a sliding window, predictive algorithm.
 - 5) Event initiated control.
 - 6) Calculated point.
 - 7) Scanning and alarm processing.
 - 8) Full direct digital control.
 - 9) Trend logging.
 - 10) Global communications.
 - 11) Maintenance scheduling.
 - r. Controller Input/Output Capability:
 - 1) Discrete/digital input (contact status).
 - 2) Discrete/digital output.
 - 3) Analog input.
 - 4) Analog output.
 - 5) Pulse input (5 pulses/second).
 - 6) Pulse output (0-655 seconds in duration with 0.01 second resolution).
 - s. Controller Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
 - 1) Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.
 - 2) Control output points but change only data base state or value; leave external field hardware unchanged.
 - 3) Enable control actions on output points but change only data base state or value.
2. Communication:
- a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
- a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:

- 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- C. Custom Application Controllers
1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
 5. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 7. Power and Noise Immunity:

- a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- D. Application Specific Controllers
- 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
 - 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
- E. Input/Output Interface
- 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
 - d. Adjust range of analog output to match range of end device, valves actuator, VFC, etc.
 - e. Program all PID loop control to match range and stroke of end device. For example if a VFC has a minimum speed of 20% output should be configure to start at 20% to eliminate spooling of PID outside actual operating range of end device.
 - f. Graphics shall represent actual range of end device. If VFC range is from 20% to 100%, graphical reference should match.
8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - 1) VAV terminal units.
 - 2) Duct mounted heating coils.
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.4 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 2. Limit connected loads to 80 percent of rated capacity.
 3. Match DC power supply to current output and voltage requirements.
 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.

5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 7. Operational Ambient Conditions: 32 to 120 degrees F.
 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
 9. Line voltage units UL recognized and CSA approved.
- B. Control Unit Battery Back-up:
1. For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.

2.5 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6 SYSTEM SOFTWARE

- A. General:
 1. Include all software required to service, program, graphic creation, and alarming in user interface accessible by owner. Intergrate with existing Trane Building Automation System operators control station.

2.7 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.

2. Provide program times for each day of week, per point, with one minute resolution.
 3. Automatically generate alarm output for points not responding to command.
 4. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.
 5. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 6. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 7. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
1. Verify the following with owner: degree of alarming, event log - item is entered into event with no warning or notification, system alarm - entered into event log with local alarm or warning message, no notification, critical alarm - enters event log, alarms at local machines, and a notification is sent, event "delays" - inform secondary recipients if primary does not acknowledge, "round robin" if required by owner, if alarm is not acknowledged by primary, secondary is notified after delay, if secondary does not acknowledge, primary will be notified again, not stopping until acknowledged.
 2. Alarm acknowledgment may be accompanied by note by operator to be entered into event log for archive and information sharing with operators.
 3. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state/value and which alarms shall cause automatic dial-out.
 4. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
 5. Display multiple alarms in order of occurrence.
 6. Define time delay for equipment start-up or shutdown.
 7. Continue to indicate unacknowledged alarms after return to normal.
 8. Binary object is set to alarm based on the operator specified state.
 9. Analog object to have high/low alarm limits.
 10. All alarming is capable of being automatically and manually disabled.
 11. Alarm Messages:
 - a. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
 - b. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.
 12. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.

- c. Reporting Options:
 - 1) Start programs.
 - 2) Print.
 - 3) Logged.
 - 4) Custom messaging.
 - 5) Graphical displays.
 - 6) Dial out to workstation receivers via system protocol.

- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
 - 1. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
 - 2. Equipment safety targets.
 - 3. Display of maintenance material and estimated labor.
 - 4. Target point reset, per point.

- G. Advisories:
 - 1. Summary which contains status of points in locked out condition.
 - 2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
 - 3. Report of power failure detection, time and date.
 - 4. Report of communication failure with operator device, field interface unit, point, programmable control unit.

- H. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.

- I. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.

- J. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.

- K. Energy Calculations:
 - 1. Accumulated instantaneous power or flow rates are converted to energy use data.
 - 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 - 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

- L. Anti-Short Cycling:
 - 1. All binary output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.

- M. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.

2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- N. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
 2. Provides operator with capability to assign high run-time alarm.
- O. Trend Point:
1. Sample up to 100 points, real or computed, with each point capable of collecting multiple samples at intervals specified in minutes, hours, days, or month.
 2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.
- P. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
 2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
 3. Operator commands:
 - a. Define single master/multiple master interlock process.
 - b. Define logic interlock process.
 - c. Lock/unlock program.
 - d. Enable/disable interlock process.
 - e. Execute terminate interlock process.
 - f. Request interlock type summary.
- Q. Input/Output Capability From Operator Work Station:
1. Request display of current values or status in tabular or graphic format.
 2. Command selected equipment to specified state.
 3. Initiate logs and reports.
 4. Change analog limits.
 5. Add, delete, or change points within each control unit or application routine.
 6. Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.
 7. Add new control units to system.
 8. Modify and set up maintenance scheduling parameters.
 9. Develop, modify, delete or display full range of color graphic displays.
 10. Automatically archive select data even when running third party software.
 11. Provide capability to sort and extract data from archived files and to generate custom reports.
 12. Support two printer operations.
 - a. Alarm printer: Print alarms, operator acknowledgements, action messages, system alarms, operator sign-on and sign-off.
 - b. Data printer: Print reports, page prints, and data base prints.
 13. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
 14. Print selected control unit data base.
- R. Operator Station:
1. Accept data from LAN as needed without scanning entire network for updated point data.
 2. Interrogate LAN for updated point data when requested.

3. Allow operator command of devices Without the purchase of additional software from any pc via web interface..
 4. Allow operator to place specific control units in or out of service.
 5. Allow parameter editing of control units.
 6. Store duplicate data base for every control unit and allow down loading while system is on line.
 7. Control or modify specific programs.
 8. Develop, store and modify dynamic color graphics.
 9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.
- S. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.
- T. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.
- U. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 2. Compose, change, or delete any message.
 3. Display or log any message at any time.
 4. Assign any message to any event.
- V. Reports:
1. Manually requested with time and date.
 2. Long term data archiving to hard disk.
 3. Automatic directives to download to transportable media such as floppy diskettes for storage.
 4. Data selection methods to include data base search and manipulation.
 5. Data extraction with mathematical manipulation.
 6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
 7. Generating reports either normally at operator direction, or automatically under work station direction.
 8. Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.
 9. Include capability for statistical data manipulation and extraction.
 10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- W. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- X. Data Collection:
1. Automatically collect and store in disk files.
 2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2 year period.
 3. Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
 4. Provide archiving of stored data for use with system supplied custom reports.
 5. Generate, store, and retrieve library symbols.
 6. Single or double height characters.

7. Sixty (60) dynamic points of data per graphic page.
8. Animated graphics for discrete points.
9. Analog bar graphs.
10. Display real time value of each input or output line diagram fashion.

2.8 HVAC CONTROL PROGRAMS

- A. General:
 1. Support Inch-pounds and SI (metric) units of measurement.
 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 4. Use outside air temperature to determine early shut down with ventilation override.
 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
- C. Supply Air Reset:
 1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
- D. Enthalpy Switchover:
 1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

- C. Provide interfaces between all equipment/systems and BMCS as indicated.
- D. Provide with 120v AC, 20 amp dedicated emergency power circuit to each programmable control unit, panel and transformer.
- E. Provide local UPS power supplies for all system panels and equipment.
- F. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of .

3.3 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
- C. Provide basic operator training for ____ persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.4 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

END OF SECTION 23 09 23

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Variable air volume air handling unit.

1.2 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Specification Compliance Review.
- C. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
 - 1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
 - 2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
 - 3. Include at least the following sequences:
 - a. System off.
 - b. Start-up.
 - c. Warm-up mode.
 - d. Normal operating mode.
 - e. Unoccupied mode.
 - f. Shutdown.
 - g. Capacity control sequences and equipment staging.
 - h. Temperature and pressure control, such as setbacks, setups, resets, etc.
 - i. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - j. Effects of power or equipment failure with all standby component functions.
 - k. Sequences for all alarms and emergency shut downs.
 - l. Seasonal operational differences and recommendations.
 - m. Interactions and interlocks with other systems.
 - 4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

- D. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
 1. Label with settings, adjustable range of control and limits.
 2. Include flow diagrams for each control system, graphically depicting control logic.
 3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 5. Include all monitoring, control and virtual points specified in elsewhere.
 6. Include a key to all abbreviations.
- E. Points List: Submit list of all control and monitor points indicating at least the following for each point.
 1. Name of controlled system.
 2. Point abbreviation.
 3. Point description; such as dry bulb temperature, airflow, etc.
 4. Display unit.
 5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
 6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
 7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
 8. Calculated point (Yes / No); i.e. a "virtual" point generated from calculations of other point values.
- F. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.4 CONTROL SYSTEM INTERFACES

- A. System shall fully support a multi-vendor environment and be able to interface and integrate third party systems and sequences via vendor protocols including, as a minimum, BACnet, LonTalk and Modbus.
- B. The Automatic Controls System and sequence of equipment operation shall be an extension of the existing Trane Building Automation System, no exceptions.
- C. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
 1. Manufacturer's packaged system control panels.
 2. Variable Frequency Controllers.
 3. Air-Handling Units.
 4. Packaged Equipment Controls
- D. A watchdog procedure must be implemented that enables the identification of the point of failure, i.e., where in the communications chain between the two systems did the failure occur. The watchdog function must operate at a frequency that detects a failure within 60 seconds.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 OPERATING SEQUENCES - GENERAL

- A. Sequence of Control indicated illustrates basic control function only. Provide all control devices required for controlling air handling units, exhaust fans, physical plant equipment, terminal equipment, and all related items. Provide monitoring only devices as indicated.
- B. Refer Floor plans for specific equipment control sequences including but not limited to Rooftop DoubleDuct Air Handling Units, Rooftop single zone air Handling Units and Double Duct Air Terminals
- C. The Control Contractor shall perform the initial input of all required operational data for each point that is to be used based on information supplied to the Contractor by the Owner. The Contractor shall assist the Owner's staff in developing the schedule and shall demonstrate the operation of the system using the data.
- D. Provide adequate English language notation in the software to assist the operator in understanding the intent of the programmed sequences.
- E. The Control Contractor shall be responsible for the stable operation of all control loops. If the Control Contractor has not provided self-tuning PID control algorithms then the Control Contractor shall manually tune all control loops. Verify all control loops are stable whether or not they are self-tuning.
- F. The Control Contractor shall provide any modifications to the operating sequence programs as requested by the Owner without additional costs until the final acceptance of the entire control system.
- G. All outputs using PID control shall be adjusted to the actual range of end device. Example: If VFC range is from 20% to 100%, output PID loop shall run from 20%-100% to eliminate spooling of PID outside actual operating range of end device.
- H. Graphics shall represent actual range of outputs.

END OF SECTION 23 09 93

SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled water piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.

1.2 CODE AND PERMIT COMPLIANCE

- A. Work shall be in accordance with all applicable codes. Where the codes and drawings do not agree, the code shall take precedence; however, code shall take precedence over what is shown only when it is more stringent than that indicated. Items that are allowed by codes which are less stringent than that indicated shall not be substituted.
- B. Contractors shall familiarize themselves with all requirements as to permits, fees, etc., and shall comply. All permits, licenses, inspections, and arrangements required for the work shall be provided by the Contractors at their expense.
- C. All utilities shall be installed in accordance with utility company rules and regulations.
- D. Drawings, plans, and schematics and diagrams indicate the general location and the arrangement of piping systems. Wherever practical, install piping as indicated.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- E. ASME B31.9 - Building Services Piping.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- G. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- H. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

- J. ASTM A536 - Standard Specification for Ductile Iron Castings.
- K. ASTM B32 - Standard Specification for Solder Metal.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- N. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
- O. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- P. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- Q. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- S. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
- T. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- U. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
- V. AWWA C606 - Grooved and Shouldered Joints.
- W. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- B. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- C. Pipe pressure testing report.
- D. Mechanical grooved joint couplings, fittings and specialties shall be shown on shop drawings and product submittals, and shall be specifically identified with the manufacturer's style or series designation.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 5 years of experience.
- C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

- D. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- E. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
- F. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
- G. All grooved joint couplings, fittings and specialties shall be the products of a single manufacturer.
 - 1. Grooving tools shall be of the same manufacturer as the grooved components.
 - 2. All castings used for coupling housings, fittings, etc., shall be date stamped for quality assurance and traceability.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical coupling joints may be used in any location.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Engineer.
 - b. Grooved mechanical connections and joints comply with AWWA C606. Couplings shall be rigid pattern, two-piece, ductile-iron housing cast with offsetting angle-pattern bolt pads.
 - 1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
 - 2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
 - c. Couplings to be bolt pad to bolt pad assembly, central cavity pressure-responsive design.
 - d. Installation-Ready, for direct stab installation without field disassembly or loose parts.
 - e. Use rigid joints unless otherwise indicated.

- f. Use flexible joints at vibrating or rotating equipment.
 - 1) Three (or four, depending on pipe size), flexible joints may be used in lieu of a flexible connector.
 - g. Use gaskets of molded grade EHP synthetic rubber with central cavity, pressure responsive configuration and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - h. Provide steel coupling nuts and bolts complying with ASTM A183.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- 1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.
- D. Valves: Provide valves where indicated:
- 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
 - 2. For throttling, bypass, or manual flow control services, use globe or ball valves.
 - 3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.2 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
- 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 - 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
- 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 - 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
 - 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 - 4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.3 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
- 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.

2. Threaded Joints: ASME B16.3, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.4 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements..
- B. Steel Pipe: ASTM A53/A53M, Schedule 40, black.

2.5 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
- C. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
- D. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- E. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
- F. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
- H. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- I. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
- J. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- K. Vertical Support: Steel riser clamp.

- L. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- M. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- N. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- O. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- P. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- Q. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- R. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- S. Steel Pipe Saddles:
 - 1. Designed for high temperature service or where heat losses are to be kept at a minimum and to protect insulation against damage at the point of support
 - 2. Conforms with Federal Specification WW-H-171 (Type 40A or 40B), Manufacturers Standardization Society ANSI®/MSS-SP-58 (Type 39)

2.6 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches and Less:
 - 1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick, preformed neoprene.
 - 4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
 - 5. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
 - 6. Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, unless thickness or specific material is indicated.
 - 1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - 2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- C. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
 - 1. Sleeve: ASTM A 126, Class B, gray iron.
 - 2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.

- D. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Installation-Ready, for direct stab installation without field disassembly or loose parts.
 2. Couplings to be bolt pad to bolt pad assembly.
 3. Coupling manufacturer's factory-trained representative shall provide on-site training for the contractor's field personnel in the proper use of grooving tools and installation of grooved joint products. The representative shall periodically visit the job site to ensure best practices in grooved joint installations are being followed.
 4. Dimensions and Testing: In accordance with AWWA C606. Couplings shall comply with ASTM F1476 "Standard Specification for the Performance of Gasketed Mechanical Couplings for use in Piping Applications".
 5. Mechanical Couplings: Comply with ASTM F1476.
 6. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 7. Gasket Material: Prelubricated, grade EHP, EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F. Central cavity pressure-responsive design.
 8. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel. ASTM A449.
 9. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 10. Manufacturers:
 - a. Grinnell Products, a Tyco Business: www.grinnell.com.
 - b. Victaulic Company: www.victaulic.com.
 11. Grooved Steel Pipe and Fittings:
 - a. Fittings: ASTM A 536, Grade 65-45-12 ductile iron;-ASTM A 53/A 53M, Type F, E, or S, Grade B factory-fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings.
 - b. Rigid Type Couplings: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B3 1.1 and B31.9.
 - c. Flexible Type Couplings: Used in locations where vibration attenuation and stress relief are required. Use three flexible couplings in lieu of a flexible connector.
- E. Pressed Fittings:
1. Copper Tube:
 - a. Copper and copper alloy press fitting shall conform to material requirements of ASME B16.18 or ASME 16.22 AND Performance criteria of IAPMO PS 117.
 - b. Sealing elements shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by the fitting manufacturer.
 - c. On sizes 1/2" to 4" the fitting shall have a feature that assures leakage of liquids and/or gases from inside the system past the sealed element of an unpressed connection. this function feature shall provide an easy indication of an unsealed connection.
- F. Dielectric Connections:
1. **Dielectric unions shall not be used.**
 2. Waterways and Nipples:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.

- c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 - e. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 degrees F
3. Flanges:
- a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.
 - f. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
4. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 degrees F.
- G. Joining Materials:
- 1. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
 - 2. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
 - 3. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.2 INSTALLATION

- A. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- B. Provide drains, consisting of a tee fitting, NPS 3/4 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 piping at a uniform grade of 0.2 percent (1 inch in 40 feet) upward in direction of flow.
- D. Provide non-conducting dielectric connections wherever joining dissimilar metals.
Dielectric unions are not allowed.
- E. Install and support in accordance with manufacturer's instructions.
- F. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.
- G. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- H. Install piping to conserve building space and to avoid interference with use of space.
- I. Group piping whenever practical at common elevations.
- J. Sleeve pipe passing through partitions, walls, and floors.
- K. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- L. Slope piping and arrange to drain at low points.
- M. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming off the top of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- N. Anchor piping for proper direction of expansion and contraction.
- O. Provide temperature and pressure test fitting (PTT) in accordance with the contract documents and as required to test and balance all equipment.
 - 1. Provide a pressure/temperature test fitting (PTT) at each water sensor that is an input point to the control system.
- P. Piping shall be installed so as to allow removal of ceiling hung equipment.
- Q. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 - 1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
 - 2. Use flexible couplings in expansion loops.
- R. Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
 - 3. Grooving tools shall be manufactured and supplied by the manufacturer of the couplings. Use roll sets or cut groovers compatible with the pipe material and wall thickness per manufacturer's installation instructions.
 - 4. Factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.
 - 5. Flexible type couplings can be used in locations where vibration attenuation and stress relief are required. Use three flexible couplings in lieu of a flexible connector.

- S. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- T. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - a. Install and support non-metalic pipe and tubing in accordance with manufacturer's instructions.
 2. Support horizontal piping as scheduled.
 3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.
 5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Provide copper plated hangers and supports for copper piping.
 9. Prime coat exposed steel hangers and supports. See Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 10. Steel Pipe Saddles:
 - a. Provide on all heating hot water piping, operating above 200 degrees F, 3" and larger.
- U. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 07 19.
- V. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.
- W. Use eccentric reducers to maintain top of pipe level.
- X. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.

3.3 INCIDENTAL WORK

- A. The following incidental work shall be furnished by the Contractor under the supervision of the Temperature Control Contractor:
1. The Piping Contractor shall install automatic valves and separable wells that are specified to be furnished by the Temperature Control Contractor.
 2. The Piping Contractor shall provide all necessary valved pressure taps, water, drain and overflow connections and piping.
 3. The Piping Contractor shall provide all necessary piping connections required for flow devices, valve position indicators, etc.

3.4 SAFETY VALVE INSTALLATIONS

- A. Provide safety valves according to ASME B31.1. Pipe safety valve discharge without valves to floor near floor drain or over mop sink.

3.5 HYDRONIC SPECIALTIES INSTALLATION

- A. Provide manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Provide automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.
- C. Provide combination air separator and strainer in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with gate valve and hose end.
- D. Provide bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve and hose end.
- E. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.
- F. Provide centrifugal separator as indicated. Install purge assembly and pipe discharge to drain. Provide pressure gauges on inlet and outlet.
- G. Provide automatic water fill assemblies wherever domestic water connections are made to HVAC hydronic systems. Provide totaling water meter on water fill makeup line.
- H. Check expansion tanks to determine that they are not air bound and that the system is completely full of water or glycol solution.

3.6 EQUIPMENT DRAINS AND OVERFLOW

- A. Piping material shall be suitable for type and temperature of drainage and location of equipment. Size piping per manufacturer's requirements and as indicated.
- B. Cooling coil condensate drainage shall be copper or PVC pipe. PVC pipe shall not be utilized in return air plenums. Condensate drain piping size (unless indicated otherwise):
 - 1. Air Handling Units and Rooftop Units:
 - a. Less than 30 tons: 1 1/4"
 - b. 31 - 50 tons: 1 1/2"
 - c. 51 - 150 tons: 2"
 - 2. Terminal Cooling, Fan Coil, Blower Coil and Furnaces:
 - a. 0 - 5 tons: 3/4"
 - b. 6 - 20 tons: 1"
- C. Route drains and overflows to nearest floor drain unless shown otherwise. Slope piping to drain at 1/8 inch per foot. Avoid crossing walking paths in mechanical rooms.

3.7 MECHANICAL GROOVED COUPLING REQUIREMENTS

- A. Grooving tools shall be manufactured and supplied by the manufacturer of the couplings. Use roll sets or cut groovers compatible with the pipe material and wall thickness per manufacturer's installation instructions.
- B. Factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The

representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Provide blinds in flanged joints to isolate equipment.
 - 5. Provide safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

- B. Perform the following tests on hydronic 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. Provide relief valve set at pressure no more than 1/3 higher than test pressure to protect against damage by expansion of liquid or other source of overpressure during the test.
 - 3. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
 - 4. Check expansion tanks to determine that they are not air bound and that system is full of water.
 - 5. Subject piping system to a hydrostatic test pressure which, at every point in the system, is not less than 1-1/2 times the design pressure assuming 125 psi minimum design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve or component on the system under the test.
 - 6. 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 either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
 - 7. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 8. Prepare written report of testing.

3.9 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

- B. Perform these adjustments before operating the system:
 - 1. Open valves to fully open position. Close coil bypass valves.
 - 2. Check pump for proper direction of rotation.
 - 3. Set automatic fill valves for required system pressure.
 - 4. Check 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. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
8. Lubricate motors and bearings.

3.10 CLEANING OF PIPING

- A. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

3.11 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 5. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
 1. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 2. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 3. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 5. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 6. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 7. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.

END OF SECTION 23 21 13

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Casings and plenums.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. NUSIG: National Uniform Seismic Installation Guidelines.
- C. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C168. In this Section, these values are the result of the formula $Btu \times in./h \times sq. ft. \times deg F$ or $W/m \times K$ at the temperature differences specified. Values are expressed as Btu or W.
 - 1. Example: Apparent Thermal Conductivity (k-Value): 0.25 or 0.037.
- D. Pressure - Velocity Classification for Ductwork: As defined by SMACNA Duct Construction Standards - Metal and Flexible (latest edition), and applicable codes. Pressure classification for this specification:
 - 1. Low Pressure: Maximum 2500 FPM velocity; maximum 2.0 inches WG positive or -2.0 inches WG negative static pressure class.
 - 2. Medium Pressure: Maximum 4000 FPM velocity; maximum 4 inches WG positive or -3.0 inches WG or greater negative static pressure class.
 - 3. High Pressure: Velocity over 4000 FPM, pressure over 4 inches WG.
- E. Gauge:
 - 1. Steel Sheet: U.S. Standard gauge.
 - 2. Aluminum Sheet: Brown & Sharpe schedule.
 - 3. Steel Wire: Washburn & Moen gauge.
- F. Concealed Insulated Surfaces: Piping, ductwork and equipment located in walls, partitions, floors, chases, shafts, alleyways, and above ceilings.
- G. Exposed Insulated Surfaces: Piping, ductwork and equipment located in mechanical rooms, tunnels and rooms without suspended ceilings.

1.3 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.

- F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
- G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
- H. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- J. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- L. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.4 PERFORMANCE REQUIREMENTS

- A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Design Professional. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.
- B. Size round ducts in lieu of rectangular ducts indicated in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

- A. Product Data: Provide data for all duct materials, duct liner, and duct connections.
- B. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
- C. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members, and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. Comply with ASHRAE and SMACNA Design Handbooks.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Ductwork shall not be stored directly on the ground. Watermarked ductwork will not be accepted for installation.
- B. Lined ductwork shall have all open ends sealed during delivery and storage periods.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with 1 standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (System with Cooling Coils): 1 inch w.g. pressure class, galvanized steel.
- D. Medium Pressure Supply: 3 inch w.g. pressure class, galvanized steel.
- E. Return and Relief: 1 inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 1 inch w.g. pressure class, galvanized steel.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
 - 1. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Water based, non-fibrated, heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 4. For Use with Flexible Ducts: UL labeled.
 - 5. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
 - 6. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 7. Duct Sealing Rolled Sealant:
 - a. Pressure sensitive, 40-year cycle, duct joint and general purpose rolled sealant. rated for use with sheet metal, duct board, flex board, PVC coated duct, and duct wrap vapor barriers.
 - b. 100 percent solid elastomeric modified butyl with aluminum foil backing.
 - c. Thickness: 17 Mils.
 - 8. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
 - 9. Flange and Joint Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

- C. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle rings connections.
- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 6. Other Types: As required.
- F. 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.

2.3 HANGERS AND SUPPORTS

- A. Hanger Materials: Galvanized, threaded steel rod or steel cable with adjustable and removable locking mechanism.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Rod and Cable Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and steel rod diameters. Comply with SMACNA and manufacturer's recommendations for cable and locking mechanism sizes.
- B. Cable Hanger System:
 - 1. Basis of Design: Gripple and Ductmate Clincher
 - 2. Products shall carry a 5:1 safety factor.
 - 3. SMACNA compliance - Tested and verified to be an acceptable hanger per the SMACNA, HVAC Duct Construction Standards.
 - 4. UL Listing - UL 1598 luminaire fitting sizes 1 - 5, UL 2289 Conduit and Cable Hardware sizes 2, 3 and 4.
 - 5. Housing: Type ZA2 Zinc.
 - 6. Wedge: Sintered steel hardened to min. 56 Rockwell C.
 - 7. Spring: 302 Stainless Steel.
 - 8. End Cap: UV stabilised homopolymer propylene.
 - 9. Wire Rope: Grade galvanized high tensile steel wire rope to EN12385.
 - 10. Toggle Plate and End Stop: Zinc plated steel.
 - 11. Stud Eyelet and Barrel End: Zinc plated steel.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.
- E. Flexible Duct Elbow Supports:
 - 1. Universal-mount, 1-piece, fully adjustable, radius-forming brace to support 4-inch through 16-inch diameter flexible air ducts.

2. Classified: UL 2043.
3. Material: 100 percent recycled copolymer polypropylene.
4. Support Frame Radius: 8 inches.
5. Compliance for Flexible Duct Radius:
 - a. SMACNA HVAC Duct Construction Standards.
 - b. ASHRAE Advanced Energy Design Guides.
 - c. ADC Flexible Duct Performance and Installation Standards.
6. Basis of Design: FlexRight (Durable Elbow Support)

2.4 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
- C. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- D. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation. Radius T's, bends and elbows less than 1-1/2 times width of duct on centerline are not allowed.
- E. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- G. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- H. Low Pressure Ductwork: Construct all ductwork using galvanized steel except as indicated.
 1. Seams and Joints: Longitudinal seams shall be grooved seams, button punch snap lock or Pittsburgh lock. Transverse joints shall be drive slip. Joints 36-inch size and larger shall be manufactured duct joining system with downset corners, no-bolt design, or SMACNA T-25 formed on flanges with corner and cleat. Contractor option on smaller sizes.
- I. Medium and High Pressure Duct: Construct all ductwork using galvanized steel except as indicated.
 1. Seams and Joints: Longitudinal seams shall be grooved seam type with sealant or gasket and center punched at 12-inch maximum intervals or Pittsburgh lock with sealant or gasket. Transverse joints shall be flanged and gasketed manufactured duct joining system with downset, bolted corner.
- J. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- K. Branch ducts to air devices shall be bell-mouth, conical or 45 degrees to round boot type fitting as a basis. Straight tap-ins, splitter dampers, and air extractors shall not be used.
- L. Duct connections to fans/air-handling units shall be designed for proper entering and leaving conditions at the fan to avoid any adverse system effect fan losses.

2.5 MANUFACTURED DUCTWORK, FITTINGS AND CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.:
 - 2. Eastern Sheet Metal.
 - 3. KB Duct
 - 4. LaPine Metal Products
 - 5. Lewis and Lambert
 - 6. Linx Industries
 - 7. Metal-Fab, Inc.: www.mtlfab.com.
 - 8. Nexus Inc.
 - 9. Norlock
 - 10. SEMCO Incorporated: www.semcoinc.com.
 - 11. S.E.T. Duct Manufacturing
 - 12. Sheet Metal Connectors.
 - 13. United McGill Corp.: www.unitedmcgill.com.
 - 14. Ward Industries, Inc.

- B. Round or Flat Oval Ducts: Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gages heavier metal than duct.
 - 1. Manufacture in accordance with SMACNA (DCS).
 - 2. Fittings: Manufacture at least two gauges heavier metal than duct.
 - 3. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

- C. Flexible Ducts: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 2. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 3. Maximum Velocity: 4000 fpm.
 - 4. Temperature Range: Minus 20 degrees F to 210 degrees F.

- D. Medium Pressure Flexible Ducts: UL 181, Class 1, aluminized laminate supported by helically wound spring steel wire.
 - 1. Inner Core: Tri-laminate of polyester, fiberglass, and aluminum foil.
 - 2. Pressure Rating: 10 inches wg positive and 10 inches wg negative.
 - 3. Maximum Velocity: 5500 fpm.
 - 4. Temperature Range: Minus 20 degrees F to 250 degrees F.

2.6 DUCT LINER

- A. Refer to Section 23 0713 - Duct Insulation.

PART 3 EXECUTION

3.1 PRE-INSTALLATION

- A. Field measure to determine exact conditions.

- B. Openings required for ductwork through structural elements in new construction shall be coordinated with the General Contractor. Shop drawings locating such openings shall be prepared in ample time to meet the construction schedule.

- C. Coordinate and install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts with a clearance of 2 inches, plus allowance for insulation thickness.
- D. Coordination Process and Drawings:
1. Provide coordination in determining adequate clearance and space requirements for mechanical equipment and electrical equipment and other items/equipment in the project. The Design Professional reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Design Professional will only review conflicts and given an opinion but will not perform as a coordinator.
 - a. The coordination process shall utilize the actual equipment being provided. Refer to manufacturer's data for physical size, access and maintenance requirements. Provide all code required clearances.
 2. Equipment layout and all system layouts shall confirm adequate clearances for installation, operation, maintenance, and code-required clearances from the structure or other equipment and systems. Provide offsets and elevation changes in piping, conduit and ductwork as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
 3. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Design Professional.
 4. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings. Access to mechanical and electrical items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Design Professional at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.
 5. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.
 6. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:
 - a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.
 - b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.
 - c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.
 7. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Design Professional and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Design Professional and the Owner.
 8. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through

accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

3.2 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
 - 1. Hanging, Sealing and Supporting:
 - a. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
 - b. Support vertical ducts at a maximum interval of 16 feet and at each floor.
 - c. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
 - d. Install concrete inserts before placing concrete.
 - e. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1) Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - f. Seal ducts before external insulation is applied.
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Keep openings covered until ready for continuing duct run or final connections. Clean all unlined supply air ductwork during installation by swabbing with a non-toxic, non-flammable cleaning agent.
- D. Flexible Ducts: Connect to metal ducts with adhesive.
 - 1. Flexible ductwork shall be attached to metal collars or sleeves with draw bands. Duct adhesive shall be added to connections as required per duct system sealing class. Metal collars or sleeves 12 inches and larger shall contain draw band holding beads.
 - 2. Low Pressure Ductwork: Peel back vapor barrier and fold back insulation; then secure to duct collar or sleeve with metal or nylon clamps or draw bands; then fold over insulation and vapor barrier and secure with two stretched wraps of approved cut tape.
 - 3. Medium Pressure Ductwork: Peel back vapor barrier and fold back insulation; then secure to duct collar or sleeve with approved duct adhesive; then secure with metal draw bands or clamps; then fold over insulation and vapor barrier and secure with two stretched wraps of approved duct tape. Take two or three tucks in vapor barrier while taping.
 - 4. Support flexible ductwork following manufacturer's recommendations and SMACNA HVAC Duct Construction Standards.
 - 5. Final connections to air inlets and outlets may be made with flexible ductwork. Expanded length of flexible ductwork shall not exceed 36 inches. Path of flexible ductwork shall not exceed 45 degrees unless flexible duct elbow supports are provided.
 - 6. Flexible Duct Elbow Supports:
 - a. Install flexible duct elbow supports in accordance with manufacturer's instructions.
 - b. Install flexible duct elbow supports over outer jacket of flexible ducts to form smooth, 90-degree bends to eliminate flexible duct kinks and airflow restrictions.
 - c. Install flexible duct elbow supports at flexible duct 90-degree bends at following locations:

- 1) Diffusers.
 - 2) Grilles.
 - 3) Registers.
 - 4) Duct take-offs and taps.
 - 5) Air devices with round inlets and outlets.
 - 6) HVAC equipment with round inlets and outlets.
 - 7) As indicated.
- E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- I. Use double nuts and flat washer on threaded rod supports.
- J. Connect terminal unit inlets to supply ducts directly or with one foot maximum length of straight run of flexible duct. Do not use flexible duct to change direction.
- K. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- L. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- M. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Penetrations:
1. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
 2. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant.
 3. Provide sleeves at all duct penetrations through walls, floors and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for full thickness of wall.
 4. Provide closure flanges around exposed ductwork at wall and ceiling penetrations, 1-1/4 inches wide minimum.
- O. Prevent passage of unfiltered air around filters with felt, rubber, neoprene gaskets, or other approved safing material.

3.3 CLEANING

- A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.
- B. Ductwork Cleanliness:
 - 1. Reference Standard: SMACNA - Duct Cleanliness for New Construction.
 - 2. Intermediate Level:
 - a. Under this level of ductwork cleanliness it is acknowledged that ductwork leaving the premises of the manufacturer will include some or all of the following:
 - 1) Internal and/or external self-adhesive labels or marking for part(s) identification.
 - 2) Exposed mastic sealant.
 - 3) Light zinc oxide coating on the metal surface.
 - 4) A light coating of oil on machine formed ductwork.
 - 5) Minor protrusions into the airway of rivets, screws, bolts and other jointing devices.
 - 6) Internal insulation and associated fasteners.
 - 7) Discoloration marks from plasma cutting process.
 - b. Site storage: The area provided for storage shall be clean, dry and exposure to dust minimized.
 - c. The working area should be clean and dry and protected from the elements.
 - d. The internal surfaces of ductwork shall be wiped to remove excess dust immediately prior to installation.
 - e. Open ends on completed ductwork and overnight work-in-progress shall be sealed.

3.4 DUCT LEAKAGE TESTING

- A. General: Perform duct leakage testing to assure that duct construction and joint sealing methods have been followed.
 - 1. Submit leakage test on SMACNA "Air Duct Leakage Test Summary" report form as found in SMACNA "HVAC Air Duct Leakage Test Manual, 2012.
 - 2. Form shall be completed in full, signed by individual performing the test, and witnessed by the Construction Manager.
- B. Minimum amount of duct leakage testing to be performed:
 - 1. Medium pressure supply air (between AHU and air terminal unit): 100%
 - 2. Low pressure supply air (between fan or air terminal and outlet): 25%
- C. Conduct tests at static pressure equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure.
- D. Ductwork minimum seal and leakage classes shall conform to applicable energy code requirements.
- E. Duct Leakage Test Criteria - Low Pressure Metal Duct:
 - 1. Duct pressure class: 1/2 - 2 inches wg
 - 2. Seal class: B
 - 3. Seal scope: Transverse joints and longitudinal seams
 - 4. Leakage class:
 - a. Rectangular Metal: 8
 - b. Round or Oval Metal: 4

- F. Duct Leakage Test Criteria - Medium Pressure Metal Duct:
 - 1. Duct pressure class: 3 inches wg
 - 2. Seal class: A
 - 3. Seal scope: Transverse joints and longitudinal seams
 - 4. Leakage class:
 - a. Rectangular Metal: 4
 - b. Round or Oval Metal: 2

3.5 FILTER REPLACEMENT

- A. All air filters shall be replaced with new prior to balancing.

3.6 ADJUSTING

- A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.

END OF SECTION 23 31 00

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Dual-duct units.

1.2 REFERENCE STANDARDS

- A. AHRI 880 (I-P) - Performance Rating of Air Terminals.
- B. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.
- C. ASTM A492 - Standard Specification for Stainless Steel Rope Wire.
- D. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems.
- I. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- J. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 SUBMITTALS

- A. Specification Compliance Review.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
 - 1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.
- D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for fan powered integral controls.

1.6 COORDINATION

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
 - 1. Coordinate maintenance clearance requirements of all terminal unit controls components prior to ordering and submitting units for review.

PART 2 PRODUCTS

2.1 PERFORMANCE, CAPACITIES AND CHARACTERISTICS

- A. See Drawings for Equipment Schedules with Equipment Performance Requirements when capacities and characteristics are not indicated in the specifications.

2.2 MANUFACTURERS

- A. Krueger.; www.krueger-hvac.com
- B. Metalaire Inc.; Metal Industries Inc.
- C. Nailor Industries Inc.: www.nailor.com.
- D. Price Industries.; www.priceindustries.com/
- E. Titus; www.titus-hvac.com
- F. Trane Inc: www.trane.com.

2.3 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, room number served, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

2.4 GENERAL

- A. Basic Assembly:
 - 1. Factory insulated casing and access door.
 - 2. Plenum Air Inlets: Round stub connections for duct attachment.

3. Plenum Air Outlets: S slip and drive connections.
 4. Access: Insulated, removable panels or doors for access , dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
- B. Basic Unit:
1. Configuration: Air volume dampers assembly inside unit casing.
 2. Locate control components inside protective metal enclosure.

2.5 DUAL-DUCT UNITS

- A. General:
1. Factory-assembled, AHRI 880 (I-P) rated, variable air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits.
 3. Basic Unit:
 - a. Configuration: Two air volume dampers inside unit casing with mixing attenuator section.
- B. Unit Casing:
1. Minimum 22 gauge, 0.0299 inch galvanized steel.
 2. Air Inlet Collars: Provide round, suitable for standard flexible duct sizes.
 3. Unit Discharge: Rectangular, with slip-and-drive connections.
 4. Acceptable Liners:
 - a. 3/4 inch thick adhesive of polyurethane or neorene foam complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
- C. Damper Assembly:
1. Heavy-gauge, galvanized steel or extruded aluminum construction with solid shaft rotating in bearings.
 2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
 3. Incorporate low leak damper blades for tight airflow shutoff.
- D. Controls:
1. DDC (Direct-Digital Controls):
 - a. Damper Actuator: 24 volt, powered open and closed.
 - b. Provide multi-point array with velocity sensors in hot-deck and cold-deck air inlet and outlet.
 - c. Terminal Unit Controller: Pressure-independent, variable air volume controller with electronic airflow transducers, factory-calibrated to minimum and maximum air volumes.
 - 1) Operating Modes: Occupied and unoccupied.
 - 2) Proportional and integral control of room temperature.
 - 3) Remote temperature or airflow set-point reset.
 - 4) Monitoring and adjusting capability with portable terminal.
 - d. Room Sensor:
 - 1) Existing double duct thermostats to be wired and replaced with Wall-mounted thermostats, compatible with temperature controls specified.
 - e. See Section 23 0923.
 2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.

- a. Plastic parts are fire-resistant, complying with UL 94.
 - b. Provides accuracy within 5 percent with a 90 degree sheet metal elbow directly at the inlet of the assembly.
 - c. Control tubing is protected by grommets at the wall of the air flow sensor's housing.
 - d. Provide sensor with a pressure transducer to interface with a DDC system.
 - e. Provide velocity pressure sensor with a removable access section for maintenance.
 - f. Signal accuracy: Plus/minus five percent throughout terminal operating range.
3. Control Sequence:
- a. Cold air damper modulates to maintain space temperature.
 - b. Hot air damper modulates to maintain constant CFM.
 - c. See Section 23 09 93.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that conditions are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions. Provide a minimum of 18" clearance to all servicable components.
- B. Provide all code required service clearances.
- C. Provide code required access clearances, 36" minimum, to all electrical components and panels.
- D. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.
- E. Coordinate locations of control components and access door or panels with installation space available. Adjusting indicated location of terminal unit and heating coil piping is acceptable if necessary to achieve required service clearances.
- F. Provide 24" x 24" ceiling access doors at each unit or locate units above easily removable ceiling components.
- G. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 05 48.
- H. Embed anchors in concrete in accordance with ASTM E488/E488M.
- I. Do not support units from adjacent ductwork.
- J. Connect to ductwork in accordance with Section 23 31 00.
- K. Verify that electric power is available and of the correct characteristics.
- L. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

- M. Provide 10" x 8" (min.) access doors upstream of reheat coils, as indicated, for cleaning and service.

3.3 CONNECTIONS

- A. Provide straight run of inlet supply ductwork as required by manufacturer.
- B. Provide flexible duct connection on discharge (supply) air connection to fan powered terminal units as indicated.
- C. Connect ductwork according to 23 3100 - HVAC Ducts and Casings. Provide inlet and outlet duct connections as recommended by air terminal unit manufacturer to achieve proper performance.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

3.5 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow.

3.6 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide manufacturer's field representative to inspect and instruct field-assembled components and equipment installation, including connections. Report results in writing.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - b. Verify that controls and control enclosure are accessible.
 - c. Verify that control connections are complete.
 - d. Verify that nameplate and identification tag are visible.
 - e. Verify that controls respond to inputs as specified.
 - 2. Operational Test:
 - a. Test and adjust controls and safeties.
 - b. Replace damaged and malfunctioning controls and other equipment.
 - c. Remove and replace malfunctioning units and retest as specified above.

3.7 CLEANING

- A. Install new filters.

END OF SECTION 23 36 00

SECTION 23 73 23

CUSTOM CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Factory fabricated assembly of modular sections consisting of housed plenum fans with direct drives, coils, filters, and other necessary modules to perform one or more of the functions of circulating, cleaning, heating, cooling, humidification, dehumidification, and mixing of air with construction suitable for outdoor applications.

1.2 REFERENCE STANDARDS

- A. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; Air-Conditioning, Heating, and Refrigeration Institute.
- B. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc..
- C. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- D. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc..
- E. AMCA 611 - Certified Ratings Program for Airflow Measurement Stations.
- F. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- G. ASHRAE Std 62.1 - Ventilation For Acceptable Indoor Air Quality.
- H. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings (ANSI/ASHRAE/IES Std 90.1).
- I. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating.
- J. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.
- K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

- B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- C. Coordination Drawings: Submit with Shop Drawings. Show rooftop layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- D. Samples: Submit two of each type of replacement filter media with frame.
- E. Manufacturer's Instructions: Include installation instructions.
- F. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 49 - Product Requirements, for additional provisions.
 - 2. Extra Fan Belts: One set for each unit.
 - 3. Extra Filters: One set for each unit.

1.4 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. Fan Module: One fan/motor module for each size and type used in the fan arrays.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of experience.
- B. Where the National Electrical Code or applicable codes require controllers to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment.

1.6 REGULATORY REQUIREMENTS

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

- B. Provide minimum three year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 PERFORMANCE, CAPACITIES AND CHARACTERISTICS

- A. See Drawings for Equipment Schedules with Equipment Performance Requirements when capacities and characteristics are not indicated in the specifications.
- B. See Drawings, Details and Diagrams for individual unit configuration, components and air pathways into, out of and through unit casing.

2.2 MANUFACTURERS

- A. ClimateCraft: www.climatecraft.com
- B. Nortek Air Solutions: www.nortekair.com.
 - 1. Governair: www.governair.com
 - 2. Temtrol: www.temtrol.com
- C. Trane Custom - Fort Smith, Arkansas: www.trane.com.

2.3 GENERAL DESCRIPTION

- A. Components:
 - 1. Casing construction.
 - 2. Coil sections.
 - 3. Filter and air cleaner section.
 - 4. Damper sections.
 - 5. Airflow measurement.
 - 6. Access and Inspection sections.
 - 7. Air blender section.
 - 8. Controls.
 - 9. Roof mounting curb.
- B. Fabrication: Conform to AMCA 99 and AHRI 430.

2.4 CASING CONSTRUCTION

- A. Full Perimeter Base Rail:
 - 1. Unit Base - Floor: Unit perimeter base shall be completely welded structural aluminum channels with welded structural aluminum cross members on 24" centers. Floor shall be constructed from 1/8" aluminum safety tread plate surface. A galvanized steel liner shall be attached to the underside of the unit encapsulating floor insulation.
 - 2. Provide base of sufficient height to raise unit for external trapping of condensate drain pans.
 - 3. C-Channel structural aluminum cross supports shall be welded to perimeter base aluminum channel and located on maximum 24" centers to provide support for internal components.
 - a. Bolted bases are not acceptable.
 - 4. Base shall include lifting lugs welded to perimeter base at the corner of the unit or each section if de-mounted.
 - 5. Base frame shall be attached to the unit at the factory.
 - 6. Entire base frame is to be painted with a phenolic coating for corrosion resistance.

- B. Casing:
1. Construct of one piece, insulated, double wall panels.
 2. Provide mid-span, no through metal, internal thermal break.
 3. Construct all unit sections inner lining, wall, roof and door panels of:
 - a. 16 gauge, solid, aluminum.
 4. Casing Air Pressure Performance Requirements:
 - a. Minimum casing thickness shall be 3 inch.
 - b. Able to withstand up to 10 inches w.g. positive or negative static pressure.
 - c. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 10 inches w.g. in all positive pressure sections and minus 10 inches w.g. in all negative pressure sections.
 5. Casing Leakage: Seal all joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.
- C. Insulation:
1. Spray foam applied to internal surfaces and structural supports.
 2. Provide minimum thermal thickness of 12 R on walls, roof and doors.
 3. Provide minimum thermal thickness of 12 R on floors.
 4. Completely fill all panel cavities in all directions preventing voids and settling.
 5. Comply with NFPA 90A.
- D. Access Doors:
1. Minimum, 24 x 60 inch insulated sandwich construction, for flush mounting, with hinges, gasket, latches, and handle assemblies.
 2. Door opening shall be fully gasketed with continuous 1/2" closed cell hollow round gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame.
 3. Provide a minimum of two (2) "Ventlok" style # 310 high pressure latches operable from either side of door.
 4. Hinges shall be easily field adjustable to account for misalignment during shipping.
 5. Construction, thickness, thermal and air pressure performance same as casing.
 6. All access doors must swing against the air pressure (i.e. positive pressure plenums doors must swing in).
 7. Fan compartments must have a door of minimum width to remove the fan motor.
 8. Access doors shall be provided with integral threaded test ports for TAB and controls testing with doors closed. Test ports shall allow no less than a 1/2" insertion probe.
- E. Inspection Doors: 18 x 22 inch of galvanized steel for flush mounting, with gasket, latch, and handle assemblies and 12 x 12 inch inspection window of 1/4 inch thick acrylic sheet.
- F. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities.
1. Internal walk-on floor shall be:
 - a. 8 gauge aluminum tread plate.
 2. The floor cavity shall be spray foam insulated.
 3. Floor seams gasketed for thermal break and sealed for airtight / watertight construction.
 4. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating.
 5. Single wall floors with glued and pinned insulation and no sub floor are not acceptable.

6. The outer sub-floor of the unit shall be made from:
 - a. 18 gauge aluminum
- G. Drain Pan Construction:
 1. Provide cooling coil sections with an insulated, double wall, stainless steel drain pan complying with ASHRAE 62.1 for indoor air quality and sufficiently sized to collect all condensate.
 2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
 3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
 4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.
- H. Bottom Inlet Units: Provide steel or aluminum walking grate on structural supports.
- I. Marine Lights:
 1. Provide factory mounted, water and dust resistant LED fixture(s) where shown on the Drawings with the following characteristics:
 - a. Non-ferrous metal housing.
 - b. Glass or polycarbonate lens.
 - c. Factory wired to a single switch within factory provided service module.
 - d. Instant on white light with minimum 8000 hour service life.
 2. Provide factory installed service module including GFCI receptacle independent from load side; designed to receive power from field supplied 120 volt source.
- J. Finish:
 1. Outdoor Units:
 - a. Coat external surface of unit casing with primer and minimum 1.5 mil, enamel paint finish.
 - b. Comply with salt spray test in accordance with ASTM B117.
 - c. Color: Manufacturer's standard color.
- K. Outdoor Unit Roof:
 1. Factory install single layer outer roof above inner roof.
 2. Slope at a minimum of 0.125 inches per foot from one side of unit to the other side, or from center to sides of unit.
 3. Roof assembly to overhang all unit walls or base rail to overhang curb to facilitate water runoff and prevent water intrusion into roof curb to base connection.
- L. Outside Air and Exhaust Air Weather Hood:
 1. Fabricate from same material as casing outer panel.
 2. Extend hood past perimeter of unit casing opening so as not to obstruct airflow path.
 3. Paint hoods with same finish as external surface of outdoor units.
 4. Provide inlet hood for each fresh air damper with a sine wave moisture eliminator to prevent entrainment of water into the unit from outside air.
 5. Provide exhaust hoods for all exhaust air openings.
 6. Size all hoods for 100 percent of nominal fresh air damper capacities.
 7. Protect all hoods with bird screens to prevent nesting into entering or leaving air flow paths.
- M. Louvers:

1. Stationary, of galvanized steel, 4 inch deep with plenum, 1/2 inch mesh, 0.04 inch galvanized wire bird screen in aluminum frame, and bearing AMCA Certified Ratings Seal in accordance with AMCA 500-L.
2. Furnish adjustable louvers with hollow vinyl bulb edging on blades and foam side stops to limit leakage to maximum 2 percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.

2.5 FAN ARRARY

- A. The system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified.
- B. Each fan array shall include the number and size of fans as scheduled.
 1. Arrays with fewer and larger fans shall not be accepted.
- C. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed.
- D. The array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed.
- E. Each fan/motor "cube" shall include an 11 gauge, A60 Galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 Galvanized steel motor support plate and structure.
- F. The fan intake wall, inlet funnel, and motor support structure shall be powder coated.
- G. All motors shall be standard pedestal mounted type, (TEFC), T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere.
- H. All motors shall include isolated bearings or shaft grounding. All motors shall be premium efficiency, IEEE inverter duty rated with appropriate winding insulation to meet NEMA MG 31, part 1, requirements.
- I. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 1.0 residual unbalance.
- J. The array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10⁻¹² watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers.
 1. The silencers shall not increase the fan total static pressure.
- K. The fan array shall consist of multiple fan and motor "cubes", the plurality of fans spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.
- L. The array shall be installed such that the optimum system operating efficiency may be achieved by manually, or automatically, enabling or disabling fans in the array to provide the minimum connected HP for the array that is necessary to produce the required air flow and pressure in the system.
- M. The fan array shall be configured such that the connected HP at reduced flow conditions may be less than the installed total HP of the array in order to achieve optimum system efficiency.

- N. Each fan cube shall be individually wired to a control panel containing a single or multiple VFC, as specified elsewhere, for the total connected HP for all fan motors contained in the array.
 - 1. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.
- O. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the array intake plenum wall, and at a distance of 48" from the discharge side of the intake plenum wall.
- P. Each fan/motor assembly shall be removable through a 30" wide, free area, access door located on the discharge or inlet side of the fan wall array.
- Q. Back Draft Damper:
 - 1. Each fan/motor cube shall contain a "near zero system effect" inlet backdraft damper shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled..
 - 2. Backdraft damper shall have the following construction details:
 - a. Frame: Formed galvanized G90, 16GA (.0635") wall thickness
 - b. Blades: Formed aluminum .063" wall thickness
 - c. Bearings: Low friction sealed metal ball bearings
 - d. Finish: Galvanized
 - e. Maximum Velocity: 2000 fpm
 - 3. The system effects for the back flow prevention damper(s) shall be included in the criteria for TSP determination for fan selection purposes, and shall be indicated as a separate line item SP loss in the submittals.
 - 4. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan.
 - a. Motorized dampers for this purpose are not acceptable.

2.6 FAN ARRAY ELECTRICAL

- A. Provide a complete electrical and control system required to run the fan array system including all equipment, material, electrical enclosure, electrical components and electrical labor.
- B. Fan array Electrical designs shall be in accordance with the NEC, UL 508A, and Local Codes.

2.7 FAN ARRAY MOTOR CIRCUIT PROTECTION:

- A. All motors in the fan array shall be provided with individual Motor Protection for thermal overload protection.
 - 1. All motor circuit protectors shall be located in main enclosure.
- B. If required by design, all motor circuit protectors shall be mounted and located in a remote motor circuit protector panel as needed that is separate from the main enclosure.
 - 1. Motor circuit protector enclosure must be located and mounted at a minimal distance from motors in the array.

2.8 SHAFT GROUNDING

- A. Manufacturers:
 - 1. AEGIS SGR
 - 2. Helwig Carbon Products

- B. Shaft grounding system for each three-phase AC motor to prevent electrical damage to motor bearings and to extend motor life by safely channeling harmful shaft currents to ground.
- C. Provide shaft grounding on all motors controlled by variable frequency controllers and as indicated.
- D. Electrographite construction. Integral shunt with quick disconnect terminal and mount.
- E. Continuous spring loaded brush holder, conductive carbon brush or carbon fiber ring technology.
- F. Replaceable without motor removal or uncoupling.
- G. Internal:
 - 1. Integral to motor housing.
- H. External:
 - 1. Bolted to motor exterior.
 - 2. Slide ring over the end of the motor shaft and locking it in place with screw on mounting brackets.

2.9 COIL SECTION

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Eliminators: Three break of Type 304 stainless steel, mounted over drain pan.
- D. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410. Refer to Section 23 82 00.

2.10 FILTER AND AIR CLEANER SECTION

- A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
- B. Cartridge Filters:
 - 1. Media: 2 inch, pleated, 13 MERV prefilter and 12 inch closely spaced, pleated, fine-fiber, cartridge filter, sealed into gasketed, metal headers, and capable of operating up to a maximum of 625 fpm for without loss of efficiency and holding capacity.
 - 2. Filter Rack: Side-access rack designed to hold the metal headers.
 - 3. Minimum Efficiency Reporting Value: 13 MERV when tested in accordance with ASHRAE 52.2.

2.11 DAMPER SECTIONS

- A. General Description: AMCA-rated, parallel or opposed-blade design as indicated;
 - 1. Operating Temperature Range: From minus 40 to plus 200 degrees F.
- B. Damper Leakage: Maximum 2 percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.
- C. Dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so

that when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

- D. Dampers used for mixing airflow shall be of the parallel blade type arranged for normally open or normally closed operation, as required.
- E. Airfoil blade dampers of double-skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 fpm or system pressure exceeds 2.5 inches w.c., but no more than 4000 fpm or 6 inches w.c.
- F. Multiple section dampers may be jack shafted to allow mounting of piston pneumatic actuators and direct-connect electronic actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.
- G. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor, return, and exhaust air.
- H. Damper Blades:
 - 1. Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on all blades.
 - 2. Self-lubricating stainless steel or synthetic sleeve bearings.
 - 3. Comply with ASHRAE 90.1 for rated maximum leakage rate.
 - 4. Base all leakage testing and pressure ratings on AMCA 500-D.
 - 5. Arrange in parallel or opposed-blade configuration.

2.12 AIRFLOW MEASUREMENT

- A. Air Flow Measurement Station:
 - 1. Provide factory installed, airflow measurement station tested in accordance with AMCA 611 and bearing the AMCA Ratings Seal for Airflow Measurement Performance.
 - 2. Station Location: Minimum (ventilation) outdoor air opening to measure ventilation airflow.
 - 3. Measurement Range: Minimum of 7.5 percent to 100 percent of unit nominal flow.
 - 4. Operation: Provide low voltage signal corresponding to actual airflow for controlling and documenting airflow.
 - 5. Accuracy: Plus/minus 5 percent.

2.13 ACCESS SECTION

- A. Provide where indicated on the Drawings to allow for inspection, cleaning, and maintenance of field installed components.
- B. Construct access doors same as previously specified within this Section.

2.14 AIR BLENDER SECTION

- A. Provide factory engineered air mixers incorporating fixed blades with no moving parts.
- B. Construction:
 - 1. Material: 0.80 inches aluminum, carbon steel, galvanized steel, aluminized steel, or stainless steel.
 - 2. Welded and mechanically fastened.
 - 3. Finish: Galvanized.
- C. Factory install with adequate distances upstream and downstream, based on cataloged performance with a minimum, effectiveness of 70 percent outside air or within plus/minus

6 degrees F of theoretical mixed air temperature, at a minimum distance of one mixer diameter downstream of the mixer.

- D. Include pressure loss due to mixer design and mixer-to-plenum ratio in the pressure drop rating for the static air mixer.

2.15 POWER AND CONTROLS

- A. Factory pre-wire all 120V power wire inside the unit including the internal lights and switch, receptacles, and ultraviolet lights for a complete pre-wired package to a unit mounted NEMA 1 enclosure.
- B. The air handling unit manufacturer shall factory pre-wire an industrial quality vapor tight light fixture in the fan section, coil section, heating coil section, filter section of all outside and other specialized units with an external switch and a separate pilot light or lighted toggle switch, near the access door and shall pre-wire a 120V ground fault circuit interrupting convenience receptacle outside th fan section.
- C. The entire air handling unit as assembled at the factory shall be UL or ETL labeled.
- D. Motor Control Panels: UL listed.
- E. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.
- F. Provide single-point field connection to power supply.
- G. Provide non fused main disconnect integral to control panel.
- H. Install wiring in accordance with NFPA 70.
- I. Refer to Division 26 specifications for addition installation requirements.
- J. Wiring: Enclosed in flexible, liquid tight steel conduit.
- K. Electrical requirements for multiple AHU VFC/Starter and motor configurations:
 - 1. Fan Array AHU with remote mounted VFC/Starter:
 - a. Each fan array VFC/Starter shall be sized for the total connected horsepower for all the fan motors contained in the fan array served.
 - b. Each fan array shall be provided with a separate motor control panel enclosure.
 - c. The enclosure shall have terminal panels and tagged terminal strips along with individual fan motor overloads and disconnect switches.
 - d. Each fan array motor shall be factory wired individually to the control panel.
 - 2. Division 26 work:
 - a. Coordinate all wiring requirements with manufacturer.
 - b. Provide all wiring from the motor terminal to the remote mounted VFC/Starter.
 - c. Provide all wiring to the unit mounted VFC/Starter.
 - d. Provide all wiring from the Division 23 provided VFC/Starters to a factory mounted NEMA 1 motor control panel enclosure.
- L. Field-Assembled Unit Sections:
 - 1. Field assembly of factory provided Power and Control wiring, serving field assembled unit sections, shall be provided by the unit manufacturer.

2.16 CONTROLS

- A. Combination Starter-Disconnects:
1. Provide combination starter-disconnect for each fan motor.
 2. Factory mount in full metal enclosure and wire to fan motor.
 3. Mount starter-disconnect on fan section externally in a NEMA 1 enclosure within a dedicated controls section or housed fan section.
 - a. Internal Enclosure Construction Characteristics:
 - 1) Integral part of unit casing to allow for thermal venting to casing interior.
 - 2) Accessible from unit exterior via access door.
 - 3) Construction of access doors same throughout unit.
 4. Include circuit breaker disconnect with through-the-door interlocking handle for externally mounted starters, spring loaded, and designed to rest only in the full and lockable ON or OFF state.
 5. Include the following items:
 - a. Hand-Off-Auto (H-O-A) switch.
 - b. Two normally open auxiliary contacts.
 - c. Overload heaters.
 - d. Manual reset overloads.
 - e. 120V control transformer with fusing and secondary grounding.
 6. Include power wiring from the starter control transformer to the secondary control system transformers, and start-stop wiring from the direct digital controller start-stop relay to the starter H-O-A switch.
- B. Fan Array Variable Frequency Control
1. Manufacturers:
 - a. ABB Inc.; www.abb.us/drives
 - b. Danfoss; www.danfossdrives.com
 - c. Reliance Electric/Rockwell Automation: www.rockwellautomation.com/relianceelectricdrives
 - d. Siemens Energy & Automation: www.sea.siemens.com.
 - e. Schneider Electric; Square D Products: www.schneider-electric.us.
 - f. Toshiba International Corporation: www.toshiba.com
 - g. Yaskawa America Inc.: www.yaskawa.com
 2. Provide one Variable Frequency Control for the entire fan array normal operation and a second Variable Frequency for Redundant Backup operation.
 - a. Provide control wiring and control circuitry to transfer from main VFC to Redundant VFC when main drive has faulted.
 3. The Variable Frequency Controls shall be sized accordingly to start and hold all motors in the array.
 - a. Provide short circuit protection for each drive through means of using fuses with fuse blocks or circuit breakers.
 4. Motor circuit protectors shall be used for each motor in the array.
 - a. Motor circuit protectors shall be housed and mounted in the VFC enclosure as required.
 - b. Variable frequency drive enclosure and remote Motor circuit protector enclosure must be mounted at a minimal distance from fan array motors and each other.
 - c. All three phase power components shall have a rating listed for Short Circuit Current Rating.
 5. Provide control wiring and components required for complete operation of fan array system.

- a. System controls, controls components and control wiring shall include but is not limited to Auto mode or manual mode, CFM control mode, or BMS control mode.
 - 6. Provide separate current transducers (CT) for each fan module.
 - a. Each CT shall be monitored remotely from the BMS to verify fan module operation.
 - 7. Controls and control wiring shall include auto start/stop, manual start stop, life safety shutdown, smoke shutdown, system alarms and VFC alarms.
 - a. All control wiring shall be included in VFC enclosure provided with system.
- C. Factory Installed Direct Digital Control (DDC) System:
 - 1. Factory engineer and test all components.
 - 2. Provide fully functional control system to operate in either stand-alone mode or as part of the building automation system (BAS) via single pair of twisted wires tie-in.
 - 3. DDC Controller:
 - 4. Control Options:
 - a. Mixing Section Spring Return Damper Actuators:
 - 1) Outdoor Air Damper: Normally closed.
 - b. Air Flow Measurement Stations: 2 to 10 VDC signal corresponding to CFM for controlling and documenting airflow.
 - c. Fan Discharge Temperature and Temperature Averaging Sensors: Suitable for integration into the BAS system.
 - d. Airflow Switches: Pipe to both filter sides to indicate fan status.
 - e. Dirty Filter Switches: Pipe to both filter sides to indicate filter status.
 - f. Condensate Overflow Switches:
- D. Factory Provided Controls for Field Installation:
 - 1. Control Valves.
 - 2. Space and Outdoor Air Temperature Sensors.

2.17 ROOF MOUNTING CURB

- A. Roof _____ Mounting Curb: 18 inches high galvanized steel, channel frame with gaskets and nailer strips.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Bolt sections together with gaskets.
- C. Isolate fan section with flexible duct connections.
- D. Make connections to coils with unions or flanges.
- E. Insulate coil headers located outside air flow as specified for piping. Refer to Section 3277.
- F. Install filter gauge on each filter bank. Refer to Section 23 3300.
- G. Coordinate with installation of HVAC equipment and install UVC Fixturing as indicated above after such equipment is properly installed.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect condensate drain pans using NPS 2", Type M copper tubing. Extend to nearest equipment or roof drain drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- D. Duct installation and connection requirements are specified in other Sections. Drawings indicate general arrangement of ducts and duct accessories.
- E. Electrical: Comply with applicable requirements in Division 26 Sections for Power Wiring, switches, and motor controls.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. 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.

3.3 FACTORY ASSEMBLY TRAINING, TESTING AND QUALITY CONTROL

- A. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM.
 - 1. All electrical circuits shall be tested to ensure correct operation before shipment of unit.
 - 2. Units shall pass quality control and be thoroughly cleaned prior to shipment.
 - 3. A written test report shall be prepared by the manufacturer and issued to the Owner's representative.
 - 4. Owner's representative shall select one unit to be tested at the time of release.

3.4 STARTUP SERVICE

- A. Final Checks before Startup: Perform the following:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connects to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - 6. Comb coil fins for parallel orientation.
 - 7. Install clean filters.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for modular air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and/or motor pulleys as required to achieve design conditions.
 - 2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.
- C. Refer to Section "Testing, Adjusting and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation of system to Owner's personnel.
1. Use operation and maintenance data as reference during demonstration.
 2. Briefly describe function, operation, and maintenance of each component.
- B. Training: Train Owner's personnel on operation and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of two hours of training.

END OF SECTION 23 73 23

SECTION 26 04 00
COMMON REQUIREMENTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY

- A. This section describes the general requirements of these specifications and shall apply to all phases of the work specified, shown on the drawings, or required to provide for complete installation of all systems for this project.
- B. This Section includes basic materials and methods to complement other Division 26 Sections.
- C. This Section includes basic materials and methods to complement Section 28 46 00 - Fire Detection and Alarm.

1.2 WARRANTIES

- A. Warrant materials, workmanship and equipment against defects for a period of one year after the date of substantial completion.
- B. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those divisions of the Project Manual.
- C. Repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period.
- D. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner.
- E. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project.
- F. The repair of faulty workmanship shall be considered to be included in the contract.

1.3 QUESTIONS OF INTERPRETATION DURING BIDDING PHASE

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Engineer for clarification.
- B. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date.
- C. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents.
- D. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- E. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.4 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, request clarification from the Engineer before proceeding with the work.

- B. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Engineer.
- C. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Engineer was requested and obtained before submission of proposed methods or materials.
- D. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 DEFINITIONS

- A. The following definitions shall apply throughout the contract documents:
 - 1. Engineer: Architect or Engineer
 - 2. Code: Applicable national, state and local codes
 - 3. Mechanical: Plumbing, HVAC, and Fire Protection work required by the Contract Documents
 - 4. Electrical: Electrical and Fire Alarm work required by the Contract Documents
 - 5. Contractor: Any Contractor performing work required by the Contract Documents
 - 6. Indicated: Noted, scheduled or specified
 - 7. Selected: Selected by the Engineer.
 - 8. Provide: Furnish, install, connect and tested complete and ready for use
 - 9. Furnish: Supply and deliver to the site ready for installation
 - 10. Install: Install complete, per Contract Documents and manufacturer's requirements.
 - 11. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - 12. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
 - 13. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
 - 14. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
 - 15. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 - 16. Dry Locations: A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.
 - 17. Damp Locations: Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.
 - a. Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold storage warehouses.
 - 18. Wet Locations: Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 SYMBOLS

- A. Items of equipment and materials are indicated on the drawings in accordance with the symbols on the plans.

1.7 ABBREVIATIONS

- A. Refer to abbreviations list on the Drawings.
- B. The following abbreviations apply throughout the Contract Documents:
 - 1. ADA: Americans with Disabilities Act
 - 2. ANSI: American National Standards Institute
 - 3. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 4. ASME: American Society of Mechanical Engineers
 - 5. ASTM Specification: Standard specifications of the American Society for Testing Materials
 - 6. FM: Factory Mutual Engineering Corporation
 - 7. IRI: Industrial Risk Insurers
 - 8. NEC: National Electrical Code, latest edition
 - 9. NEMA: National Electrical Manufacturers Association
 - 10. NFPA: National Fire Protection Association
 - 11. UL or Underwriters: Underwriters Laboratories, Inc.

1.8 CODES

- A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards.
- B. The work shall conform to all applicable sections of currently adopted editions of the following codes, standards, and specifications:
 - 1. International Building Code (IBC)
 - 2. International Fire Code (IFC)
 - 3. International Energy Conservation Code (IECC)
 - 4. Safety and Health Regulations for Construction
 - 5. Occupational Safety and Health Standards (OSHA), National Consensus Standards and Established Federal Standards
 - 6. National Electrical Code (NEC)
 - 7. National Electrical Safety Code (NESC)
 - 8. National Fire Protection Association (NFPA)
 - 9. Life Safety Code (NFPA 101)
 - 10. Factory Mutual Global Engineering (FMG)
 - 11. Underwriters' Laboratories, Inc. (UL)
 - 12. National Electrical Manufacturers Association (NEMA)
 - 13. Institute of Electrical and Electronics Engineers (IEEE)
 - 14. Insulated Power Cable Engineers Association (IPCEA)
 - 15. Applicable national, state and local codes
- C. Where there is a conflict between the code and the Contract Documents, the code shall have precedence only when it is more stringent than the Contract Documents.
 - 1. Items that are allowed by the code but are less stringent than those specified shall not be substituted.

1.9 PERMITS

- A. The Contractors shall familiarize themselves with requirements regarding permits, fees, etc., and shall comply with them.

- B. Permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.
- C. Utilities shall be installed in accordance with the local rules and regulations. Charges shall be paid by the Contractor.

1.10 MATERIALS AND EQUIPMENT MANUFACTURERS

- A. Options in selecting materials and equipment are limited by requirements of the contract documents and governing regulations. They are not controlled by industry traditions or procedures experienced on previous construction projects.
- B. Materials and equipment shall be provided in accordance with the following:
 - 1. Primary Design Products: Primary design products are those products around which the project was designed in terms of capacity, performance, physical size and quality.
 - 2. Primary design products are indicated by use of a single manufacturer's name, model number or similar data on drawings or schedules or within the specifications.
 - 3. Provide primary design products unless substitutions are made in accordance with the following paragraphs.
 - 4. Acceptable Equivalent Substitutions: Acceptable equivalent substitutions are products of manufacturers other than those listed for the primary design products. Equivalent acceptable substitutions shall meet each of the following requirements:
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the Project Manual, drawings, or addenda.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance, and physical characteristics.
 - c. The Contractor providing the substitution shall bear the total cost of changes due to substitutions. These costs may include additional compensation to the Engineer for redesign and evaluation services, increased cost of work by the Owner or other Contractors, and similar considerations.
 - 5. Performance Requirements: Where the contract documents list performance requirements or describe a product or assembly generically, provide products that comply with the specific requirements indicated and that are recommended by the manufacturer for the respective application.
 - 6. Compliance with Standards, Codes and Regulations: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including the standards, codes and regulations.
- C. Proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, delivery time requirements, and the availability of repair or replacement parts may also be considered.
- D. The Engineer shall be the sole and final judge as to the suitability of substitution items.

1.11 SUBMITTALS

- A. Shop Drawings, Product Data and Samples:
 - 1. Other sections in the Project Manual shall be adhered to if more stringent than the following paragraphs.
 - 2. When required by other sections of this Project Manual, submit shop drawings, product data or samples to the Engineer for review.

3. Submittals deemed unnecessary by the Engineer shall be returned indicating "No Action Taken".
4. A completed copy of the transmittal form included with the Project Manual shall accompany each submittal.
5. Submittals shall be numbered consecutively.
6. Unless otherwise noted, submit one copy electronically of shop drawings and product data for review. Review comments will be returned electronically. A hard copy of the electronic submittal will be returned if requested.
7. Where samples are required, submit one (1) sample of each required item.
8. Shop drawings are drawings, diagrams, schedules and other data specifically prepared for this project by the Contractor, Manufacturer, Supplier, or Distributor to illustrate some portion of the work. Shop Drawings shall also detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
 - a. Shop drawings shall be drawn to accurate scale and of adequate size to illustrate required details.
9. Product data are illustrations, standard schedules, performance charts, instruction brochures, diagrams and other information furnished by the Contractor, Manufacturer, Supplier, or Distributor to illustrate a material, product or system for some portion of the work.
10. Samples are physical examples furnished by the Contractor, Manufacturer, Supplier, or Distributor to illustrate materials, equipment or workmanship and to establish the standards by which the work will be performed.
11. Each submittal shall clearly indicate proposed items, capacities, characteristics and details in conformance with contract documents. Equipment items shall be marked with the same item number as used on drawings or schedules. Capacities, dimensions and special features required shall be certified by the manufacturer.
12. Submittals shall indicate manufacturer's delivery time for the item after review by the Engineer.
13. When required by other sections of this Project Manual, the Contractor shall submit a Specification Compliance Review consisting of a paragraph-by-paragraph review of the specifications and addenda with the following marked for each paragraph. Markings may be made in the margins of the original specification or addenda. Unless a deviation or exception is specifically noted in the Specification Compliance Review, it is assumed that the equipment, product, or material is in complete compliance with the contract documents. Submit Specification Compliance Review with shop drawings and product data.
 - a. "C": Comply with no exceptions.
 - b. "D": Comply with minor deviations. For each deviation, provide the reasons for the deviation and how the intent of the specification can be satisfied.
 - c. "E": Exception. Equipment, product, or material does not comply. For each exception, provide reasons for the exception, and suggest possible alternatives for the Owner's consideration.
 - d. "N/A": The paragraph does not apply to the proposed equipment, product, or material.
14. The Engineer shall review or take other appropriate action upon the Contractor's submittals such as shop drawings, product data and samples, but only to determine conformance with the design concept of the work and the information given in the contract documents.
15. Contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Engineer's review of shop drawings, product data or samples.

16. Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Engineer's review of those drawings.
 17. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Engineer. Such portions of the work shall be in accordance with reviewed submittals.
 18. The successful Contractor/Supplier may, at their option, obtain DXF or AutoCad DWG electronic drawing files for use in preparation of shop drawings.
 - a. This information is available from Alvine Engineering upon written request.
 - b. A non-refundable handling charge of \$10.00 per drawing file requested will be required at the time of receipt of the electronic files.
 - c. The use of these drawing files is intended solely for the preparation of drawings as required by these contract documents.
 - d. Any other use is strictly prohibited by copyright laws.
 - e. The user of these electronic drawing files assumes full responsibility for their accuracy and scale.
- B. Operation and Maintenance Manuals:
1. Prepare three (3) operation and maintenance manuals for the equipment furnished. Manuals shall be submitted to the Engineer for review and distribution to the Owner not less than 30 days prior to substantial completion of the project. Manuals not meeting the following requirements may be rejected by the Engineer.
 2. Each manual shall be assembled in a three-ring binder with hard cover and plastic finish. Binders shall not exceed a 3-inch thickness. Where more than one binder is required, the manuals shall be separated into a logical grouping, i.e., "Mechanical", "Electrical", "Maintenance", "Operation", "Parts", "Shop Drawings", etc. Each binder shall have the following information clearly printed on its front cover:
 - a. Project name and address.
 - b. Portion of the work covered by each volume (if more than one volume in the set). Where more than one volume is required, label each volume as "Volume _____ of _____".
 - c. Name, address and telephone number of Contractor and Sub-Contractors including night or emergency number.
 3. Manual shall include, but shall not be limited to, the following:
 - a. A Complete Index. Contractor may submit the index to the Engineer for review prior to submittal of complete manuals if desired.
 - b. Names, Addresses and Telephone Numbers. This list shall include the manufacturer and local representative who stocks or furnishes repair parts for all items of equipment and shall be typed on a single page in front of the binder.
 - c. Startup, Operation and Shutdown Procedures. Provide a written description of procedures for startup, operation and shutdown of each electrical item or system. This description shall include switches to operate, buttons to push, etc., in proper sequence, and the location of switches, starters, and pushbuttons. Description shall include item references or labels used in the contract documents unless otherwise instructed in advance by the Owner.
 - d. Equipment Accessory Schedule. Upon completion of the work, furnish the Owner with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required and the manufacturer of renewable items.

- e. Manufacturer's Operation and Maintenance Manuals and Parts Lists.
- f. Emergency Procedures. Provide a written description of emergency operating procedures or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency services to the various parts of the system.
- g. One copy of shop drawings and product data, clearly marked for each item furnished using the designation label specified or indicated on Drawings.
- h. Manufacturers' warranty information.
- i. Normal Maintenance Schedule. Include a listing of work to be performed at various time intervals; i.e., 30, 90, 180 days and yearly.

1.12 QUALITY ASSURANCE

- A. Conform to the requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.13 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. 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.
- C. 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.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- E. Coordinate electrical testing of electrical, mechanical, or architectural items so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
- F. Provide offsets and elevation changes in conduit and cable tray as required to complete the Layout and Coordination Process.

1.14 STRUCTURAL COORDINATION

- A. In cases where the Contractor determines that superimposed loads such as suspended or floor mounted electrical system or equipment exist which exceed design loads indicated on structural contract documents, Contractor shall submit load data to Engineer for review prior to proceeding with work.

- B. Distribute the maximum load hung from any structural member for mechanical, electrical, plumbing, ductwork, piping, etc. over the member's tributary area in a way that the design superimposed dead loads listed in structural contract documents are not exceeded. The Contractor shall coordinate the loads and provide additional support or distribution framing as required achieving the allowable load distribution.
- C. Connections of systems designed by Contractor's engineer such as, but not limited to mechanical, electrical, plumbing loads are assumed to impose vertical and/or horizontal loads on the base building structural members without generating torsion in the supporting structural members. Contractor is responsible for furnishing and installing all supplementary bracing members as required to prevent torsion on the base building structure.

PART 2 PRODUCTS

2.1 PERFORMANCE, CAPACITIES AND CHARACTERISTICS

- A. See Drawings for Equipment Schedules for Equipment Performance Requirements when capacities and characteristics are not indicated in the specifications.

2.2 EQUIPMENT SHORT CIRCUIT CURRENT RATING

- A. Where the National Electrical Code or applicable codes require equipment to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment. Acceptable methods of complying with this requirement are as follows:
 - 1. Provide SCCR rating at the equipment that meets or exceeds the available short circuit current at the switchboard or panelboard where the equipment circuit originates.
 - 2. Provide calculations, based on the available short circuit current at the switchboard or panelboard where the equipment circuit originates, that document the actual short circuit current available at the equipment. The SCCR rating of the equipment shall meet or exceed this calculated value.

2.3 MATERIALS

- A. Unless otherwise specified, all materials and equipment shall be new, unused and undamaged. Materials and equipment shall be the current and standard designs of manufacturers regularly engaged in their production.

2.4 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

- A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details and requirements.

2.5 QUANTITY OF SPECIFIED ITEMS REQUIRED

- A. Wherever in these specifications an article, device or piece of equipment is referred to in the singular number; such reference shall apply to as many such articles as are shown on the drawings or required to complete the installation.

PART 3 EXECUTION

3.1 GENERAL

- A. Fabrication, erection, and installation of the complete electrical system shall be done by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up the progress of the project.
- B. Check areas and surfaces where electrical equipment or materials are to be installed and report any unsatisfactory conditions before starting work.
- C. Commencement of work signifies the Contractor's acceptance of the conditions as fit and proper for the execution of the electrical work.
- D. Install equipment and systems in accordance with manufacturer's instructions, requirements, or recommendations.
- E. Comply with NECA 1.
- F. Unless otherwise noted, measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- G. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- H. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- I. Right of Way: Give to raceways and piping systems installed at a required slope.
- J. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 DELIVERY AND STORAGE OF MATERIALS

- A. Make provisions for the delivery and safe storage of materials. Make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.
- B. Materials shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.
- C. Adequately protect supplies and equipment during cold weather.
- D. Protect items subject to cold weather damage by covering, insulating, or storing in a heated space.

3.3 COOPERATION WITH OTHER CONTRACTORS

- A. Perform the electrical work in conformance with the construction called for by other trades and afford other contractors reasonable opportunity for the execution of their work.
- B. Properly connect and coordinate the electrical work with the work of other contractors at such time and in such a manner as not to delay or interfere with their work.
- C. Examine the contract documents for the General, Mechanical, and Electrical work and the work of other trades. Coordinate work accordingly.

- D. Promptly report to the Engineer any delay or difficulties encountered in the installation of the electrical work which might prevent prompt and proper installation of work required from other trades.

3.4 COORDINATION OF WORK

- A. Plan work so it proceeds with a minimum of interference with other trades.
- B. Inform the General Contractor of all openings required in the building construction for the installation of the electrical work.
- C. Cooperate with other contractors in furnishing material and information, in proper sequence, for the correct location of sleeves, inserts, foundations, wiring, etc.
- D. Make provisions for special frames, openings, and sleeves as required.
- E. The Electrical Contractor shall pay for extra cutting and patching made necessary by his failure to properly direct such work at the correct time.

3.5 LAYING OUT WORK

- A. Carefully lay out work in advance of installation using data and measurements from the site, the appropriate civil, architectural, and structural drawings, and shop drawings.
- B. Confirm code required clearances.
- C. Do not infringe upon space required for operation, maintenance, or clearance for items installed by other contractors.
- D. Prior to installation of any work, make certain the location does not conflict with other items in or near the same location.
- E. If the layouts so prepared indicate that the required conditions cannot be met in the space provided, inform the Engineer prior to installation and request clarification.
- F. Failure to properly coordinate and lay out work will require correction by the Contractor at the Contractor's expense

3.6 DATA AND MEASUREMENTS

- A. Mechanical and Electrical drawings are diagrammatic or schematic. Do not scale drawings.
- B. The data given herein and on the drawings is as accurate as could be secured; absolute accuracy is not guaranteed.
- C. Obtain exact locations, measurements, levels, etc., at the site and adapt their work to actual conditions.
- D. Examine the General Construction, Mechanical, Electrical, and other applicable drawings and the Specifications.
- E. Utilize only site measurements in calculations.
- F. Layout and coordinate work prior to installation to provide clearances for operation, maintenance and codes. Verify non-interference with other work.
- G. Install outlets and devices with vertical edges of plates plumb.
- H. Install boxes or plaster rings such that the front edge extends to the finished surface of the wall, ceiling or floor without projecting beyond the surface.

- I. Coordinate locations of outlets and devices with other contractors so as not to destroy the aesthetic effect of the surface in which the outlets and devices are mounted. Coordinate the locations of electrical items with work furnished by other trades to avoid interference.
- J. Heights of outlets are measured from finished floor to centerline of device.
- K. Adjust heights as necessary to clear wall-mounted cabinets, fin tube convectors, unit heaters, etc.
- L. Mounting heights shall be in compliance with ADA requirements.
- M. The mounting heights of disconnect switches, circuit breakers, motor controllers, pushbutton stations and other similar devices and equipment may vary depending upon location and whether individually or group mounted.
- N. For convenience and safety, mount equipment with the center of operating levers, handles or buttons no more than 72 inches above the finished floor.
- O. Locate individual devices or pieces of equipment, unless otherwise specified, so the operating handle, lever or button is located approximately 5 feet above finished floor. Coordinate heights of electrical items with work furnished by other trades to avoid interferences.
- P. Improperly located devices or outlets shall be relocated by the Contractor at the Contractor's expense including necessary patching.

3.7 PROTECTION OF APPARATUS

- A. Take necessary precautions to properly protect apparatus, fixtures, appliances, material, equipment, and installations from damage.
- B. Failure to provide such protection to the satisfaction of the Engineer shall be sufficient cause for the rejection of any particular piece(s) of material, apparatus, equipment, etc., concerned.

3.8 FIRESTOPPING

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

3.9 WORK IN EXISTING BUILDINGS

- A. Execute work in the existing building, indicated on the drawings or specified herein, with a minimum amount of interference with the normal activities of the occupants of the building.
- B. Schedule work in advance with the Owner and proceed only with the Owner's written approval.
- C. Utilities:
 - 1. Do not interrupt utilities without the Owner's prior written approval regarding the time and duration of such interruptions.
 - 2. Do not disconnect utilities to existing facilities until new or temporary facilities are installed except for short periods of interruption which are necessary for the performance of the new work and which are approved by the Owner.
 - 3. Storm water may be temporarily diverted to surface drainage provided such drainage is arranged to prevent flooding of structures, basements and excavations for construction.
- D. Fire Alarm System:

1. As a minimum, maintain the existing degree of protection for all areas throughout construction.
 2. Coordinate required outages with the Owner and the Fire Marshal.
 3. After any additions or modifications to the fire alarm system, a re-acceptance test shall be performed by a licensed party in accordance with NFPA 72.
- E. Welding:
1. Notify the Owner before starting welding or cutting.
 2. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc.
 3. Stop operations involving welding or cutting with an open flame or arc not less than one hour before leaving the premises.
- F. Noisy Operations:
1. Schedule noisy operations, such as those involving use of air hammers, etc., in demolition or cutting of openings, with the Owner.
- G. Occupancy:
1. The Owner will continue to occupy the building and carry on normal activity.
 2. Protect the occupied areas from dust, smoke, etc., by a method reviewed by the Engineer.
- H. Owner's Right to Direct Work: The Owner shall have the right to direct the places of beginning work, its prosecution, and the manner in which all work under this contract is to be conducted, insofar as may be necessary to secure the safe and proper progress and quality of the work.
- I. Existing Conduits or Electrical Equipment:
1. Remove or relocate, as required, or as directed by the Engineer, existing conduit or electrical equipment which would interfere with the proper installation of new work.
 2. Modify existing work in conformance with these specifications.
 3. Use the same materials as for new work unless otherwise specified.

3.10 DEMOLITION AND REMODEL

- A. Protect existing electrical equipment and installations indicated to remain.
- B. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- D. 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.
- E. Remove demolished material from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Remove existing lights, receptacles, switches, etc., indicated on plans or which are not indicated but must be removed to accommodate demolition or new remodeling.
- H. Where existing walls are indicated to be removed, disconnect power to electrical devices and associated appurtenances relating to the walls.

- I. Maintain circuit continuity up and down stream from removed outlets.
- J. Extend circuiting to up and downstream devices and reconnect as required.
- K. Where existing site lighting fixtures are removed, verify the routing of existing circuits. Maintain circuit continuity between existing fixtures which remain.
- L. In areas which are remodeled, replace existing wire with new wire. No existing wire is permitted to remain unless noted.
- M. Existing concealed conduit and boxes may be reused.
- N. Verify existing conditions in field prior to bid date.

3.11 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations.
- B. Perform cutting by skilled mechanics of trades involved.
- C. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.
- D. Install new fireproofing where existing firestopping has been disturbed.
- E. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.12 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work. Repair as necessary.

3.13 CLEANING AND PROTECTION

- A. Remove burrs, dirt, paint spots, and construction debris from electrical items.
- B. Protect electrical items so that finishes are without damage or deterioration at time of Substantial Completion.

3.14 TEMPORARY POWER AND LIGHTING

- A. Provide temporary power and lighting throughout the construction period for the use by all trades, Contractors and Sub-Contractors.
- B. Temporary facilities shall be installed in compliance with applicable codes and in compliance with OSHA requirements.
- C. Cost of temporary power used during construction, including the cost of setting and removing temporary service, shall be paid by the Contractor.
- D. Where existing building electrical system is used to provide temporary power and lighting, energy costs shall be paid by the Owner.

END OF SECTION 26 04 00

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.

1.2 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- H. NFPA 70 - National Electrical Code.
- I. UL 44 - Thermoset-Insulated Wires and Cables.
- J. UL 83 - Thermoplastic-Insulated Wires and Cables.
- K. UL 486A-486B - Wire Connectors.
- L. UL 486C - Splicing Wire Connectors.
- M. UL 486D - Sealed Wire Connector Systems.
- N. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Minimum Conductor Size:
 1. Branch Circuits: 12 AWG.
 2. Control Circuits: 14 AWG.
- I. Conductor Color Coding:
 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.

- 3) Phase C: Blue.
- 4) Neutral/Grounded: White.
- c. Equipment Ground, All Systems: Green.
- d. For control circuits, comply with manufacturer's recommended color code.

2.2 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN, THHN/THWN-2, or XHHW-2, except as indicated below.

2.3 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- C. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
- D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- G. Mechanical Connectors: Provide bolted type or set-screw type.
- H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.4 ACCESSORIES

- A. Electrical Tape:
 - 1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant

- to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Circuiting Requirements:
 1. When circuit destination is indicated without specific routing, determine exact routing required.
 2. Install service and feeder conductors unspliced unless otherwise indicated.
 3. Arrange branch circuiting to minimize splices.
 4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than 6 #12 AWG current-carrying conductors in 1/2 inch conduit; 9 #12 AWG current-carrying conductors in 3/4 inch conduit.
 - b. Provide no more than 6 #10 AWG current-carrying conductors in 3/4 inch conduit; 9 #10 AWG current-carrying conductors in 1 inch conduit.
 - c. Provide no more than 4 #8 AWG current-carrying conductors in 3/4 inch conduit; 6 #8 AWG current-carrying conductors in 1 inch conduit; 9 #8 AWG current-carrying conductors in 1-1/4 inch conduit.
 7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.

- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
 - 1. Pull all conductors and cables together into raceway at same time.
 - 2. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 3. Use suitable wire pulling lubricant where necessary, except as below:
 - a. Do not use when lubricant is not recommended by the conductor manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Install conductors with a minimum of 6 inches of slack at each outlet.
- G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- I. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors or heat shrink tubing.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- K. Insulate ends of spare conductors using vinyl insulating electrical tape.
- L. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- M. Identify conductors and cables in accordance with Section 26 05 53.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements.

- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NFPA 70 - National Electrical Code.
- C. UL 467 - Grounding and Bonding Equipment.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for metal building frame.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare tinned copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use compression connectors for accessible connections. For #6 AWG and smaller, use one-hole lugs. For #4 AWG and larger, use two-hole lugs.
 - a. Exceptions:
 - 1) Use exothermic welded connections or high-pressure compression connections for connections to metal building frame.
 3. Manufacturers - High-Pressure Compression Connectors:
 - a. Burndy: www.burndy.com; Hyground System
 - b. Thomas & Betts: www.tnb.com.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).

- C. Install each bonding conductor in a direct route, and parallel or perpendicular to building structure or surfaces, without interfering with other systems or equipment.
- D. Install exterior grounding electrode conductors with a minimum bending radius of 12 inches.
- E. Install interior grounding conductors with a minimum bending radius of 8 inches.
- F. Install grounding conductors in EMT conduit unless otherwise indicated. Bond each end of the conduit to the grounding conductor using an appropriate grounding bushing.
- G. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- H. Identify grounding and bonding system components in accordance with Section 26 05 53.
 - 1. Clean each surface prior to attachment of label.
 - 2. Follow manufacturer's recommendations for affixing labels.

3.3 FIELD QUALITY CONTROL

- A. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- B. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts or expansion anchors.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood: Use wood screws.
- G. Cable Supports for Vertical Conduit: Factory-fabricated body with insulated wedging plug, appropriately sized for conductors being supported.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3-1/2 inch high concrete pad.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
 - 6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.
- J. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

END OF SECTION 26 05 29

SECTION 26 05 33.13

CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flexible metal conduit (FMC).
- B. Liquidtight flexible metal conduit (LFMC).
- C. Galvanized steel electrical metallic tubing (EMT).
- D.
- E. Accessories.

1.2 REFERENCE STANDARDS

- A. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NFPA 70 - National Electrical Code.
- E. UL 1 - Flexible Metal Conduit.
- F. UL 360 - Liquid-Tight Flexible Metal Conduit.
- G. UL 514B - Conduit, Tubing, and Cable Fittings.
- H. UL 797 - Electrical Metallic Tubing-Steel.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.4 QUALITY ASSURANCE

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Outdoor Locations Above Grade: Use electrical metallic tubing.
- C. Dry Locations:
 - 1. Concealed: Use electrical metallic tubing.
 - 2. Exposed: Use electrical metallic tubing.
- D. Connection to Motors: Use liquid-tight flexible metal conduit, except use flexible metal conduit in air plenums.
- E. Connection to Vibrating Equipment (including transformers):
 - 1. Indoors: Use flexible metal conduit.
 - 2. Outdoors: Use liquid-tight flexible metal conduit.

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2-inch trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 FLEXIBLE METAL CONDUIT (FMC)

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

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360; rated for use with conductors rated 75 degrees C.
- B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel, malleable iron, or die cast zinc.

2.5 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel, malleable iron, or die cast zinc.
 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.6 ACCESSORIES

- A. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 200 lbf.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. When conduit destination is indicated without specific routing, determine exact routing required.
 3. Conceal conduits unless specifically indicated to be exposed.
 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 5. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 7. Arrange conduit to maintain adequate headroom, clearances, and access.

8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 9. Exterior Branch Circuits: Route conduits adjacent to curbs. Push or directional bore conduits beneath paved areas; otherwise, sawcut and remove pavement. Replace removed pavement to match existing.
 10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 11. Maintain minimum clearance of 12 inches between conduits and hot surfaces.
 12. Group parallel conduits in same area on common rack.
- D. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use of spring steel conduit clips for support of conduits is permitted only as follows:
 - a. Support of electrical metallic tubing (EMT) 1-1/2 inch trade size concealed above accessible ceilings and within hollow stud walls.
 5. Use of wire for support of conduits is permitted only as follows:
 - a. For suspending conduits supported by spring steel conduit clips, where specifically indicated or permitted.
- E. Connections and Terminations:
1. Use suitable adapters where required to transition from one type of conduit to another.
 2. Provide insulated bushings on box connectors 1-inch and larger, on conduits stubbed above an accessible ceiling, and on conduits used for telecommunications pathways.
 3. Secure joints and connections to provide mechanical strength and electrical continuity.
- F. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Seal interior of conduits entering building from underground at first accessible point to prevent entry of moisture and gases.
 4. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 5. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 6. Install firestopping to preserve fire resistance rating of partitions and other elements.
- G. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.

- 2. Where conduits are subject to earth movement by settlement or frost.
- H. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide junction box or type C conduit with approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 - 3. Where conduits penetrate coolers or freezers.
- I. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- J. Provide grounding and bonding; see Section 26 05 26.
- K. Identify conduits; see Section 26 05 53.
- 3.3 FIELD QUALITY CONTROL
 - A. Correct deficiencies and replace damaged or defective conduits.
- 3.4 CLEANING
 - A. Clean interior of conduits to remove moisture and foreign matter.
- 3.5 PROTECTION
 - A. Immediately after installation of conduit, use suitable caps to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- F. NFPA 70 - National Electrical Code.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 508A - Industrial Control Panels.
- J. UL 514A - Metallic Outlet Boxes.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 - 3. Use suitable concrete type boxes where flush-mounted in concrete.
 - 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 - 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 - 6. Do not use "through-wall" boxes designed for access from both sides of wall.
 - 7. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 - 8. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 - 9. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
 - 1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 - 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 - 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Include cable supports if any dimension of the box is greater than 48 inches.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- G. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes as required for devices installed under other sections or by others.
 - 4. Locate boxes so that wall plates do not span different building finishes.
 - 5. Locate boxes so that wall plates do not cross masonry joints.
 - 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
 - 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in unfinished areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- H. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- P. Provide grounding and bonding in accordance with Section 26 05 26.
- Q. Identify boxes in accordance with Section 26 05 53.
- R. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
- S. Orient each box located above an accessible ceiling so the box opening faces down or to one side.
- T. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- U. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- V. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

3.3 CLEANING

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

END OF SECTION 26 05 33.16

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Identification for conductors.
- D. Warning signs and labels.

1.2 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify electrical equipment.
 - a. Panelboards:
 - 1) Identify panelboard name.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Use typewritten circuit directory to identify load(s) served for panelboards with a door.
 - 4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device.
 - 2. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
- B. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.

2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- C. Identification for Boxes:
1. Use handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Color: White text on black background.
- B. Identification Labels:
1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
 4. Color: Black text on clear background. Provide black text on white background when applying to a dark surface.
- C. Format for Equipment Identification:
1. Minimum Size:
 - a. Plastic Nameplates: 1 inch by 2.5 inches.
 - b. Identification Labels: 0.5 inch by 2.5 inches.
 2. Legend:
 - a. Equipment designation or other approved description.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. Equipment Designation: 3/8 inch.

2.3 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: inside of equipment door when installed in a finished location.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Boxes: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws or self-adhesive backing and to interior surfaces using self-adhesive backing.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 05 53

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Overcurrent protective devices for panelboards.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 407 - Standard for Installing and Maintaining Panelboards.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA PB 1 - Panelboards.
- E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- F. NFPA 70 - National Electrical Code.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 67 - Panelboards.
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- K. UL 943 - Ground-Fault Circuit-Interruptioners.
- L. UL 1699 - Arc-Fault Circuit-Interruptioners.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- C. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Panelboard Keys: six of each different key.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com.
- B. Eaton Corporation: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier, where possible.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

- b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating as indicated on the drawings. Where the available fault current is indicated, provide panelboards with listed short circuit current rating not less than the available fault current.
 - 2. Listed series ratings are acceptable only where specifically indicated.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation. Do not reduce panelboard pole quantity or mounting spaces indicated on drawings by installation of branch-mounted main device, where used. Provide additional poles or spaces as required.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum or copper.
 - 2. Ground Bus Material: Aluminum or copper.

- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.
 - 3. Minimum dimensions: 6-1/2 inches deep, 26 inches wide.
- F. Panelboard Construction: Lighting and appliance panelboard construction is not acceptable.
- G. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 - 6. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
 - 7. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
 - 8. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
 - 9. Do not use tandem circuit breakers.
 - 10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
 - 11. Provide the following features and accessories where indicated or where required to complete installation:

- a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad.
- I. Provide grounding and bonding in accordance with Section 26 05 26.
- J. Install all field-installed branch devices, components, and accessories.
- K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- M. Provide filler plates to cover unused spaces in panelboards.
- N. Identify panelboards in accordance with Section 26 05 53.
- O. If the overcurrent protection for a panelboard feeder is less than the nameplate rating of the panelboard, provide a plastic nameplate indicating the ampacity of the feeder circuit. Attach nameplate to the inside of the panelboard so it is visible when the panelboard door is opened.
- P. Connections:
 - 1. Connect phase conductors A, B, C left to right as viewed from the front of the panel unless bus bars are factory labeled otherwise.
 - 2. Connect each branch circuit served by a lighting and appliance branch circuit panelboard to a 20A 1-pole breaker unless otherwise indicated.

3. Circuit numbering indicated for lighting and appliance branch circuit panelboards is based on pole position within the panelboard. For multipole breakers, the circuit number corresponds to the first pole position occupied by the breaker.
4. Circuit number indicated for distribution panelboards is based on consecutive numbering.

3.3 FIELD QUALITY CONTROL

- A. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- B. Test GFCI circuit breakers to verify proper operation.
- C. Test AFCI circuit breakers to verify proper operation.
- D. Test shunt trips to verify proper operation.
- E. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 24 16

SECTION 26 05 26
GROUNDING AND BONDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NFPA 70 - National Electrical Code.
- C. UL 467 - Grounding and Bonding Equipment.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify Owner/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for metal building frame.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare tinned copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections or high-pressure compression connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use compression connectors for accessible connections. For #6 AWG and smaller, use one-hole lugs. For #4 AWG and larger, use two-hole lugs.
 - a. Exceptions:
 - 1) Use exothermic welded connections or high-pressure compression connections for connections to metal building frame.
 4. Manufacturers - High-Pressure Compression Connectors:
 - a. Burndy: www.burndy.com; Hyground System
 - b. Thomas & Betts: www.tnb.com.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install each bonding conductor in a direct route, and parallel or perpendicular to building structure or surfaces, without interfering with other systems or equipment.
- D. Install exterior grounding electrode conductors with a minimum bending radius of 12 inches.
- E. Install interior grounding conductors with a minimum bending radius of 8 inches.
- F. Install grounding conductors in EMT conduit unless otherwise indicated. Bond each end of the conduit to the grounding conductor using an appropriate grounding bushing.
- G. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

3.3 FIELD QUALITY CONTROL

- A. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- B. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Owner/Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.4 QUALITY ASSURANCE

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- D. Metal Channel/Strut Framing Systems:
1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 2. Comply with MFMA-4.
 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Hollow Masonry: Use toggle bolts or expansion anchors.
 5. Hollow Stud Walls: Use toggle bolts.
 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 7. Sheet Metal: Use sheet metal screws.
 8. Wood: Use wood screws.
- G. Cable Supports for Vertical Conduit: Factory-fabricated body with insulated wedging plug, appropriately sized for conductors being supported.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Owner/Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Owner/Engineer, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3-1/2 inch high concrete pad.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
 - 6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. Secure fasteners in accordance with manufacturer's recommended torque settings.
- I. Remove temporary supports.
- J. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

END OF SECTION

SECTION 26 05 33.13

CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flexible metal conduit (FMC).
- B. Liquidtight flexible metal conduit (LFMC).
- C. Galvanized steel electrical metallic tubing (EMT).
- D. Accessories.

1.2 REFERENCE STANDARDS

- A. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NFPA 70 - National Electrical Code.
- E. UL 1 - Flexible Metal Conduit.
- F. UL 360 - Liquid-Tight Flexible Metal Conduit.
- G. UL 514B - Conduit, Tubing, and Cable Fittings.
- H. UL 797 - Electrical Metallic Tubing-Steel.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
 - 5. Notify Owner/Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.4 QUALITY ASSURANCE

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Outdoor Locations Above Grade: Use electrical metallic tubing.
- C. Dry Locations:
 - 1. Concealed: Use electrical metallic tubing.
 - 2. Exposed: Use electrical metallic tubing.
- D. Connection to Motors: Use liquid-tight flexible metal conduit, except use flexible metal conduit in air plenums.
- E. Connection to Vibrating Equipment (including transformers):
 - 1. Indoors: Use flexible metal conduit.
 - 2. Outdoors: Use liquid-tight flexible metal conduit.

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2-inch trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 FLEXIBLE METAL CONDUIT (FMC)

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

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360; rated for use with conductors rated 75 degrees C.
- B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel, malleable iron, or die cast zinc.

2.5 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Colored EMT:
 1. Manufacturer: Allied Tube and Conduit.
- C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel, malleable iron, or die cast zinc.
 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.6 ACCESSORIES

- A. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 200 lbf.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. When conduit destination is indicated without specific routing, determine exact routing required.
 3. Conceal conduits unless specifically indicated to be exposed.
 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 5. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits

parallel or perpendicular to building structure and surfaces, following surface contours where practical.

7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
9. Exterior Branch Circuits: Route conduits adjacent to curbs. Push or directional bore conduits beneath paved areas; otherwise, sawcut and remove pavement. Replace removed pavement to match existing.
10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
11. Maintain minimum clearance of 12 inches between conduits and hot surfaces.
12. Group parallel conduits in same area on common rack.

D. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use of spring steel conduit clips for support of conduits is permitted only as follows:
 - a. Support of electrical metallic tubing (EMT) 1-1/2 inch trade size concealed above accessible ceilings and within hollow stud walls.
5. Use of wire for support of conduits is permitted only as follows:
 - a. For suspending conduits supported by spring steel conduit clips, where specifically indicated or permitted.

E. Connections and Terminations:

1. Use suitable adapters where required to transition from one type of conduit to another.
2. Provide insulated bushings on box connectors 1-inch and larger, on conduits stubbed above an accessible ceiling, and on conduits used for telecommunications pathways.
3. Secure joints and connections to provide mechanical strength and electrical continuity.

F. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
4. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
5. Install firestopping to preserve fire resistance rating of partitions and other elements.

G. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- H. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant, junction box, or type C conduit at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- I. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- J. Provide grounding and bonding; see Section 26 05 26.
- K. Identify conduits; see Section 26 05 53.
- 3.3 FIELD QUALITY CONTROL
- A. Correct deficiencies and replace damaged or defective conduits.
- 3.4 CLEANING
- A. Clean interior of conduits to remove moisture and foreign matter.
- 3.5 PROTECTION
- A. Immediately after installation of conduit, use suitable caps to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- E. NFPA 70 - National Electrical Code.
- F. UL 514A - Metallic Outlet Boxes.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Do not use "through-wall" boxes designed for access from both sides of wall.
 7. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 8. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 9. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 10. Wall Plates: Comply with Section 26 27 26.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

- F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- G. Box Locations:
1. Locate boxes to be accessible. Provide access panels as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes as required for devices installed under other sections or by others.
 4. Locate boxes so that wall plates do not span different building finishes.
 5. Locate boxes so that wall plates do not cross masonry joints.
 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in unfinished areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- H. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- P. Provide grounding and bonding in accordance with Section 26 05 26.
- Q. Identify boxes in accordance with Section 26 05 53.
- R. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
- S. Orient each box located above an accessible ceiling so the box opening faces down or to one side.
- T. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- U. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- V. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

3.3 CLEANING

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

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Identification for conductors.
- D. Warning signs and labels.

1.2 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code.

1.3 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify electrical equipment.
 - a. Enclosed switches:
 - 1) Identify load(s) served.
- B. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- C. Identification for Raceways:
 - 1. Use underground warning tape to identify underground raceways.
- D. Identification for Boxes:
 - 1. Use handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.
- E. Identification for Devices:
 - 1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Color: White text on black background.
- B. Identification Labels:
1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
 4. Color: Black text on clear background. Provide black text on white background when applying to a dark surface.
- C. Format for Equipment Identification:
1. Minimum Size:
 - a. Plastic Nameplates: 1 inch by 2.5 inches.
 - b. Identification Labels: 0.5 inch by 2.5 inches.
 2. Legend:
 - a. Equipment designation or other approved description.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. Equipment Designation: 3/8 inch.

2.3 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Labels:
 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: inside of equipment door when installed in a finished location.

3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Boxes: Outside face of cover.
 6. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
 - D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws or self-adhesive backing and to interior surfaces using self-adhesive backing.
 - E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
 - F. Mark all handwritten text, where permitted, to be neat and legible.
- 3.3 FIELD QUALITY CONTROL
- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 83
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 REFERENCE STANDARDS

- A. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- B. NFPA 70 - National Electrical Code.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 2. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

- C. Provide receptacle outlet to accommodate connection with attachment plug.
- D. Provide cord and cap where field-supplied attachment plug is required.
- E. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- F. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- G. Provide interlocks and wiring to and between controls for Owner-furnished equipment, air handling units, fans, rooftop units, furnaces, and condensing units.
- H. Verify control wiring requirements with manufacturer certified shop drawings for each piece of equipment or control system and install accordingly. Install control wiring in conduit.

3.3 EQUIPMENT REQUIREMENTS

- A. Temperature Control / Energy Management System Panels:
 - 1. Provide a dedicated power circuit from the nearest 120 V general purpose panel to each temperature control, energy management system, or data gathering panel.
 - 2. Coordinate panel quantities and locations with Installing Contractor.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Lighting and appliance panelboards.
- B. Overcurrent protective devices for panelboards.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 407 - Standard for Installing and Maintaining Panelboards.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA PB 1 - Panelboards.
- E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- F. NFPA 70 - National Electrical Code.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 67 - Panelboards.
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Owner/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current

ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- C. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. Panelboard Keys: six of each different key.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com.
- B. Eaton Corporation: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier, where possible.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating as indicated on the drawings. Where the available fault current is indicated, provide panelboards with listed short circuit current rating not less than the available fault current.
 2. Listed series ratings are acceptable only where specifically indicated.
 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation. Do not reduce panelboard pole quantity or mounting spaces indicated on drawings by installation of branch-mounted main device, where used. Provide additional poles or spaces as required.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.3 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 2. Phase and Neutral Bus Material: Aluminum or copper.
 3. Ground Bus Material: Aluminum or copper.
- D. Circuit Breakers: Thermal magnetic bolt-on type.

- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide clear plastic circuit directory holder mounted on inside of door.
 - 4. Minimum dimensions: 5-1/2 inches deep, 20 inches wide.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 - 6. Do not use tandem circuit breakers.
 - 7. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Install all field-installed branch devices, components, and accessories.
- J. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- L. Provide filler plates to cover unused spaces in panelboards.
- M. Identify panelboards in accordance with Section 26 05 53.
- N. If the overcurrent protection for a panelboard feeder is less than the nameplate rating of the panelboard, provide a plastic nameplate indicating the ampacity of the feeder circuit. Attach nameplate to the inside of the panelboard so it is visible when the panelboard door is opened.
- O. Connections:
 1. Connect phase conductors A, B, C left to right as viewed from the front of the panel unless bus bars are factory labeled otherwise.
 2. Connect each branch circuit served by a lighting and appliance branch circuit panelboard to a 20A 1-pole breaker unless otherwise indicated.
 3. Circuit numbering indicated for lighting and appliance branch circuit panelboards is based on pole position within the panelboard. For multipole breakers, the circuit number corresponds to the first pole position occupied by the breaker.
 4. Circuit number indicated for distribution panelboards is based on consecutive numbering.

3.3 FIELD QUALITY CONTROL

- A. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- B. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Device plates and box covers.

1.2 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- C. NFPA 70 - National Electrical Code.
- D. UL 20 - General-Use Snap Switches.
- E. UL 498 - Attachment Plugs and Receptacles.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
 - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 5. Notify Owner/Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cooper Wiring Devices: www.cooperwiringdevices.com.
- B. Hubbell Incorporated: www.hubbell-wiring.com.
- C. Leviton Manufacturing Company, Inc: www.leviton.com.
- D. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
- E. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.

2.2 WIRING DEVICE FINISHES

- A. Device Color: Ivory unless otherwise indicated or required by code; brown in dark brick, wood paneled or dark-finished walls.

2.3 WALL SWITCHES

- A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Acceptable products are listed below for specific device types.
- C. Standard Switches: 20A, 120/277 V AC

Description	Cooper	Hubbell	Leviton	P & S
Single pole	CSB120	CSB120	CS120-2	CSB20AC1
Double pole	CSB220	CSB220	CS220-2	CSB20AC2
Three-way	CSB320	CSB320	CS320-2	CSB20AC3
Four-way	CSB420	CSB420	CS420-2	CSB20AC4

2.4 RECEPTACLES

- A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- B. Acceptable products are listed below for specific device types.
- C. Straight Blade Receptacles: 20A, 125V.

Description	Cooper	Hubbell	Leviton	P & S
Simplex	1877	HBL5361	5891	5361
Duplex	BR20	BR20	5362	CRB5362
Duplex tamper resistant	TRBR20	BR20TR	T5362	TR5362
Duplex GFCI	SGF20	GFRST20	GFNT2	2097
Duplex GFCI tamper resistant	TRSGF20	GFTRST20	GFTR2	2097TR

Duplex GFCI weather resistant	WRSGF20	GFWRST20	GFWT2	2097TRWR
Duplex GFCI weather resistant, tamper resistant	WRSGF20	GFTWRST20	GFWR2	2097TRWR
Duplex isolated ground	IG5362	IG20CR	5362-IG	IG5362
Duplex tamper resistant with USB charging ports	TR7756	USB20A5	T5832	TR5362USB
Duplex TVSS	5362S	HBL5362SA	7380	5362SP
Clock hanger	775V	RR151CHI	688	S3713

2.5 WALL PLATES

- A. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
- B. Install wiring devices in accordance with manufacturer's instructions.
- C. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- D. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

- E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer or by using screw-actuated pressure plate. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- G. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices unless otherwise indicated.
- H. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- I. Install wall switches with OFF position down.
- J. Install vertically mounted receptacles with grounding pole on bottom.
- K. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- L. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.

3.4 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- C. Test each receptacle to verify operation and proper polarity.
- D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses.
- B. NFPA 70 - National Electrical Code.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Owner/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fuses: Three of each type and size, unless a greater quantity is indicated on drawings.
 - 2. Fuse Pullers: One set(s) compatible with each type and size installed.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.
- B. Littelfuse, Inc: www.littelfuse.com/#sle.
- C. Mersen: ep-us.mersen.com/#sle.

2.2 APPLICATIONS

- A. Fuses 600 Amps or Smaller: Class RK1, time delay, equivalent to Bussmann Low Peak. Provide with open fuse indication where available.
- B. Plug Fuses: Class S, time delay, equivalent to Bussmann Fustat. Provide with a Bussmann catalog number SSY device cover incorporating a switch and fuse holder.

Where a lockable switch is required, provide a Bussmann catalog number SOY box cover with fuse holder mounted adjacent to a locking toggle switch.

2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. For motor circuits, provide fuses rated at 125 percent of motor nameplate full load current.
- C. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. NFPA 70 - National Electrical Code.
- E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- G. UL 98 - Enclosed and Dead-Front Switches.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Owner/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- B. Project Record Documents: Record actual locations of enclosed switches.
- C. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.electrification.us.abb.com.
- B. Eaton Corporation: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier, where possible.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Provide with switch blade contact position that is visible when the cover is open.
- G. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 - 1. Switches 600 Amps or smaller: Class R.
 - 2. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

- L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- M. Heavy Duty Switches:
 - 1. Comply with NEMA KS 1.
 - 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- N. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 60 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Identify enclosed switches in accordance with Section 26 05 53.
- J. Install fuses in fusible disconnect switches.
- K. Bolt closed exterior grade level enclosures.

3.3 FIELD QUALITY CONTROL

- A. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

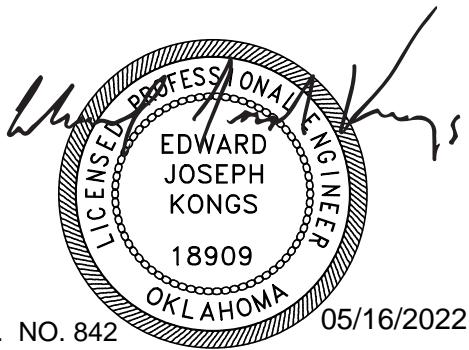
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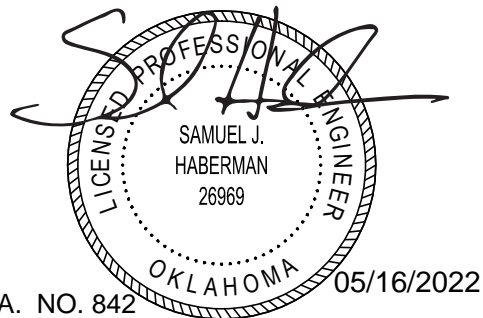
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C.A. NO. 842 05/16/2022
EXPIRES 30/JUNE/2022



C.A. NO. 842 05/16/2022
EXPIRES 30/JUNE/2022

SECTION 23 04 00
COMMON REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the general requirements of these specifications and shall apply to all phases of the work indicated or required to provide for complete installation of all systems for this project.
- B. This Section includes basic materials and methods to complement other Division 23 Sections.

1.2 WARRANTIES

- A. Warrant all materials, workmanship and equipment against defects for a period of one year after the date of substantial completion.
- B. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those divisions of the Project Manual.
- C. Repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period.
 - 1. Repair or replacement of compressorized equipment shall include a complete refrigerant charge.
- D. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner.
- E. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project.
- F. The repair of faulty workmanship shall be considered to be included in the contract.

1.3 QUESTIONS OF INTERPRETATION DURING BIDDING PHASE

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Owner/Engineer for clarification.
- B. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date.
- C. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents.
- D. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- E. The Owner/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.4 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, request clarification from the Owner/Engineer before proceeding with the work.

- B. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Owner/Engineer.
- C. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Owner/Engineer was requested and obtained before submission of proposed methods or materials.
- D. The Owner/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 DEFINITIONS

- A. The following definitions shall apply throughout the contract documents:
 1. Owner/Engineer: Architect or Engineer
 2. Code: All applicable national, state and local code
 3. Mechanical: All plumbing, HVAC, & fire protection work required by the Contract Documents
 4. Electrical: All electrical and fire alarm work required by the Contract Documents
 5. Contractor: Any Contractor performing work required by the Contract Documents
 6. Indicated: Shown on drawings, noted, scheduled or specified
 7. Selected: Selected by the Architect or Engineer
 8. Provide: Furnish, install, connect and tested complete and ready for use
 9. Furnish: Supply and deliver to the site ready for installation
 10. Install: Install complete, per Contract Documents and manufacturer's requirements.
 11. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 12. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
 13. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
 14. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
 15. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 16. Dry Locations: A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.
 17. Damp Locations: Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.
 - a. Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold storage warehouses.
 18. Wet Locations: Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 SYMBOLS

- A. Items of equipment and materials are indicated on the drawings in accordance with the symbols shown on the plans.

1.7 ABBREVIATIONS

- A. Refer to abbreviations list shown on the Drawings.

1.8 CODES

- A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards.
- B. All work shall conform to all applicable sections of currently adopted editions of the following codes, standards, and specifications:
 1. International Building Code (IBC)
 2. International Fire Code (IFC)
 3. International Energy Conservation Code (IECC)
 4. International Fuel Gas Code (IFGC)
 5. International Plumbing Code (IPC)
 6. International Mechanical Code (IMC)
 7. Safety and Health Regulations for Construction
 8. Occupational Safety and Health Standards (OSHA), National Consensus Standards and Established Federal Standards
 9. National Electrical Code (NEC)
 10. National Fire Protection Association (NFPA)
 11. Life Safety Code (NFPA 101)
 12. American Gas Association (AGA)
 13. Underwriters' Laboratories, Inc. (UL)
 14. National Electrical Safety Code (NESC)
 15. All applicable national, state and local codes and amendments.

1.9 PERMITS

- A. The Contractors shall familiarize themselves with all requirements regarding all permits, fees, etc., and shall comply with them.
- B. All permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.
- C. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.10 CODE COMPLIANCE

- A. Work shall be in accordance with all applicable codes. Where the codes and drawings do not agree, the code shall take precedence; however, code shall take precedence over what is shown only when it is more stringent than that indicated. Items that are allowed by codes which are less stringent than that indicated shall not be substituted.
- B. Drawings, plans, and schematics and diagrams indicate the general location and the arrangement of systems. Wherever practical, install systems as indicated.
- C. Where the National Electrical Code or applicable codes require controllers to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment.

1.11 MATERIALS AND EQUIPMENT MANUFACTURERS

- A. Options in selecting materials and equipment are limited by requirements of the contract documents and governing regulations. They are not controlled by industry traditions or procedures experienced on previous construction projects.
- B. Materials and equipment shall be provided in accordance with the following:
 - 1. Primary Design Products: Primary design products are those products around which the project was designed in terms of capacity, performance, physical size and quality.
 - 2. Primary design products are indicated by use of a single manufacturer's name, model number or similar data on drawings or schedules or within the specifications.
 - 3. Provide primary design products unless substitutions are made in accordance with the following paragraphs.
 - 4. Acceptable Equivalent Substitutions: Acceptable equivalent substitutions are products of manufactures other than those listed for the primary design products. Equivalent acceptable substitutions shall meet each of the following requirements:
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the Project Manual, drawings, or addenda.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance, and physical characteristics.
 - c. The Contractor providing the substitution shall bear the total cost of all changes due to substitutions. These costs may include additional compensation to the Owner/Engineer for redesign and evaluation services, increased cost of work by the Owner or other Contractors, and similar considerations.
 - d. Performance Requirements: Where the contract documents list performance requirements or describe a product or assembly generically, provide products that comply with the specific requirements indicated and that are recommended by the manufacturer for the respective application.
 - e. Compliance with Standards, Codes and Regulations: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including the standards, codes and regulations.
 - f. Proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, delivery time requirements, and the availability of repair or replacement parts may also be considered.
 - g. The Owner/Engineer shall be the sole and final judge as to the suitability of substitution items.

1.12 SUBMITTALS

- A. Shop Drawings, Product Data and Samples:
 - 1. Other section in the Project Manual shall be adhered to if more stringent than the following paragraphs.
 - 2. When required by other sections of this Project Manual, submit shop drawings, product data or samples to the Owner/Engineer for review.
 - 3. Submittals deemed unnecessary by the Owner/Engineer shall be returned indicating "No Action Taken".

4. A completed copy of the transmittal form included with the Project Manual shall accompany each submittal.
 5. Submittals shall be labeled indicating the specification number and title, shop drawing or product data description and the respective Part 2 paragraph and sub-paragraph numbers.
 6. Submittals not listed in the Project manual shall reference the respective contract document.
 7. Unless otherwise noted, submit one copy electronically of shop drawings and product data for review. Review comments will be returned electronically. A hard copy of the electronic submittal will be returned if requested.
 - a. Shop drawings and product data shall be in original searchable PDF format.
 8. Shop drawings are drawings, diagrams, schedules and other data specifically prepared for this project by the Contractor, Manufacturer, Supplier, or Distributor to illustrate some portion of the work. Shop Drawings shall also detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
 - a. Shop drawings shall be drawn to accurate scale and of adequate size to illustrate required details.
 9. Product data are illustrations, standard schedules, performance charts, instruction brochures, diagrams and other information furnished by the Contractor, Manufacturer, Supplier, or Distributor to illustrate a material, product or system for some portion of the work.
 10. All submittals shall clearly indicate proposed items, capacities, characteristics and details in conformance with contract documents. All equipment items shall be marked with the same item number as used on drawings or schedules. Capacities, dimensions and special features required shall be certified by the manufacturer.
 11. Submittals shall indicate manufacturer's delivery time for the item after review by the Owner/Engineer.
 12. The Owner/Engineer shall review or take other appropriate action upon the Contractor's submittals such as shop drawings, product data and samples, but only to determine conformance with the design concept of the work and the information given in the contract documents.
 13. Contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Owner/Engineer's review of shop drawings, product data or samples.
 14. Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Owner/Engineer's review of those drawings.
- B. Operation and Maintenance Manuals:
1. Prepare electronic operation and maintenance manuals for the equipment furnished.
 2. The manual shall be in original searchable PDF format with equipment organized by specification section. Bookmarking shall be provided in the PDF for each specification section and piece of equipment.
 3. Manuals shall be submitted to the Owner/Engineer for review and distribution to the Owner not less than 30 days prior to substantial completion of the project.
 4. Manuals not meeting the requirements of this section may be rejected by the Owner/Engineer.
 5. Manual shall include, but shall not be limited to, the following:
 - a. A cover page including:
 - 1) Project name and address
 - 2) Division of work covered by the manual

- 3) Name, address and telephone number of Contractor and all Sub-Contractors including night or emergency numbers
- b. A Complete Index. Contractor may submit the index to the Owner/Engineer for review prior to submittal of complete manuals if desired.
- c. Manufacturer's equipment product data O&M manuals and parts lists identified by the equipment mark used in the contract drawings.
- d. Names, Addresses and Telephone Numbers. This list shall include the manufacturer and local representative who stocks or furnishes repair parts for all items of equipment and shall be typed on a single page in front of the manual.
- e. Startup, Operation and Shutdown Procedures. Provide a written description of procedures for startup, operation and shutdown of each item or system. This description shall include motors to start, valves to open, etc., in proper sequence, and the location of switches, starters, pushbuttons and valves. Description shall include item references or labels used in the contract documents unless otherwise instructed in advance by the Owner.
- f. Seasonal Changeover Procedure. Provide a written description of the procedure for necessary seasonable changeover from heating to cooling and vice versa.
- g. Equipment Accessory Schedule. Upon completion of the work, furnish the Owner with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required and the manufacturer of all renewable items.
- h. Lubrication Schedule. Provide a chart listing each piece of equipment, the proper type of oil or grease required, and recommended frequency of lubrication.
- i. Emergency Procedures. Provide a written description of emergency operating procedures or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency services to the various parts of the system.
- j. One copy of all shop drawings.
- k. Signed letters of certification of inspection and similar information.
- l. All manufacturers' warranty information.
- m. Provide documentation that training was performed for each item specified to include Owner training. Include name of Owner's representative(s) present, date and time of training.
- n. Normal Maintenance Schedule. Include a listing of work to be performed at various time intervals; i.e., 30, 90, 180 days and yearly.
- o. Provide documentation that Extra Materials were received by the Owner for each section requiring Extra Materials.
- p. Motor List. The list shall indicate motor location, equipment served (using labels indicated on drawings), horsepower, electrical characteristics, motor type, and rpm. Motors less than 1/2 horsepower need not be included.

1.13 OPERATING TRAINING

- A. Complete operating instructions for each system and item of equipment shall be provided to the Owner's designated personnel.
- B. Operation and Maintenance Manuals must be reviewed and accepted by the Owner/Engineer and provided to the Owner prior to operating training.

- C. Training shall be scheduled at the convenience of the Owner. A minimum of 4 hours, per system, of training shall be provided.
- D. Training shall include instructions on the following:
 1. Startup and shutdown procedures
 2. Seasonal changeover
 3. Periodic maintenance
 4. Emergency operation
 5. Safety
- E. In addition to the instructions required above, wherever possible perform the operations being described in order to fully illustrate system operation.
- F. At the completion of training, turn over to the Owner all required keys and special tools for installed equipment. Each key or tool shall be labeled with its use.

1.14 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel".
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping".
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.15 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.16 COORDINATION

- A. Drawings, plans, and schematics and diagrams indicate the general location and the arrangement of systems. Wherever practical, install systems as indicated.
- B. Provide offsets and elevation changes in piping, conduit and ductwork as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
- C. Arrange for spaces, chases, slots, and openings in building structure during progress of construction to allow for system installations.
- D. Coordinate arrangement, mounting, and support of equipment.
 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
- E. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the installations that follow.
1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- F. Sequence, coordinate, and integrate installing materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- G. Coordinate service connections to components furnished by utility companies.
1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for metering components.
 2. Comply with requirements of authorities having jurisdiction and of utility company providing water, gas, electrical power and other services.
- H. Coordinate location of access panels and doors for items that are concealed by finished surfaces.
- I. Coordinate testing of items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.17 STRUCTURAL COORDINATION

- A. In cases where the Contractor determines that superimposed loads such as suspended or floor mounted mechanical, electrical, plumbing system or equipment exist which exceed design loads indicated on structural contract documents, Contractor shall submit load data to Design Professionals for review prior to proceeding with work.
- B. Distribute the maximum load hung from any structural member for mechanical, electrical, plumbing, ductwork, piping, etc. over the member's tributary area in a way that the design superimposed dead loads listed in structural contract documents are not exceeded. The Contractor shall coordinate the loads and provide additional support or distribution framing as required achieving the allowable load distribution.
- C. Connections of systems designed by Contractor's engineer such as, but not limited to mechanical, electrical, plumbing loads are assumed to impose vertical and/or horizontal loads on the base building structural members without generating torsion in the supporting structural members. Contractor is responsible for designing, furnishing and installing all supplementary bracing members as required to prevent torsion on the base building structure.
- D. Coordinate locations of new fire suppression, plumbing and HVAC penetrations through existing structure and construction. Utilize all existing documentation of conditions for coordination. Verify penetrations utilizing GPR (Ground Penetrating Radar) as necessary to confirm penetration locations.

PART 2 - PRODUCTS

2.1 PERFORMANCE, CAPACITIES AND CHARACTERISTICS

- A. See Drawings for Specific Notes and/or Equipment Schedules with Equipment Performance Requirements when capacities and characteristics are not indicated in the specifications.

2.2 EQUIPMENT SHORT CIRCUIT CURRENT RATING

- A. Where the National Electrical Code or applicable codes require equipment to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment. Acceptable methods of complying with this requirement are as follows:
 - 1. Provide SCCR rating at the equipment that meets or exceeds the available short circuit current at the switchboard or panelboard where the equipment circuit originates.
 - 2. Provide calculations, based on the available short circuit current at the switchboard or panelboard where the equipment circuit originates, that document the actual short circuit current available at the equipment. The SCCR rating of the equipment shall meet or exceed this calculated value.

2.3 CONTROL SYSTEM INTERFACES

- A. Equipment and systems shall be able to interface and integrate to the existing Trane BMCS systems and sequences via vendor protocols including, as a minimum, BACnet.
- B. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
 - 1. Manufacturer's packaged system controllers and control panels.
 - 2. Packaged Unitary Equipment.

2.4 MATERIALS

- A. Unless otherwise specified, all materials and equipment shall be new, unused and undamaged. Materials and equipment shall be the current and standard designs of manufacturers regularly engaged in their production.

2.5 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

- A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details and requirements.

2.6 QUANTITY OF SPECIFIED ITEMS REQUIRED

- A. Wherever in these specifications an article, device or piece of equipment is referred to in the singular number; such reference shall apply to as many such articles as are shown on the drawings or required to complete the installation.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 PIPE OR CONDUIT PENTERATION HOUSING & HOODS

- A. Manufacturer:
 1. RPH; www.RoofPenetrationHousings.com
- B. References:
 1. ICC-500, FEMA 320/361 – Third Party Tested to +225 mph
 2. ICC 2015 Energy Code – Third Party Tested to ASTM E 2078-13 Standard Test Method for Air Permeance of Building Materials
 3. ASTM E 1980 Solar Reflectance Index (SRI)
 4. FEMA P749 – Seismic Provisions
- C. Lid and housing lined with insulation to a minimum value of R-19.
- D. Warranty: 20 years.
- E. Roof Mounted: Engineered penetration housing, accommodating up to 18 pipes/conduits- cables, water, refrigeration, and power in one roof penetration with high rain tight integrity.
- F. Roof penetration system is constructed of 14 gauge UV powder coated, welded, galvanized steel or aluminum with stainless steel hardware.
 1. Removable, gasketed lid to housing and housing to curb connection joints, pitched cover.
 2. Exit seal construction to be manufactured in all aluminum construction and 100% Sil-X-14 silicone gaskets.
 3. All seals must be protected from UV with an aluminum or stainless steel jacket.
- G. Coordinate size of housing and hoods with all trades utilizing the penetration.
- H. Furnish with 18-inch tall insulated curb and extensions for roof applications.

2.9 ROOF MOUNTED PIPE, DUCTWORK AND CONDUIT SUPPORT SYSTEMS

- A. Manufactures:
 1. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
 2. Eaton, Dura-Blok.
 3. Erico International Corporation: www.erico.com.
 4. PHP Systems/Design, www.phpsd.com
 5. Unistrut, UNIpier.
- B. Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 1. Bases: UV resistant material, molded polycarbonate resin, HDPE or rubber.
 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 3. Stut style, galvanized steel horizontal and vertical supports, attaching hardware.
 4. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

5. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
6. Height: Provide minimum clearance of 18 inches under pipe to top of roofing.
 - a. Adjustable mounting height.
7. Operating temperature: -30F to 150F.

2.10 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psig, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.11 SEALANTS AND FIRESTOPPING

- A. Manufacturers:
 1. Sealants:
 - a. Dow Corning
 - b. Pecora
 - c. Sonneborn
 - d. Tremco
 2. Firestopping Materials and Systems:
 - a. A/D Fire Protection Systems Inc: www.adfire.com.
 - b. 3M Fire Protection Products: www.3m.com/firestop.
 - c. Hilti, Inc: www.us.hilti.com.
 - d. Nelson FireStop Products: www.nelsonfirestop.com.
 - e. Specified Technologies, Inc: www.stifirestop.com.
 - f. Tremstop Fyre-Sil Sealant - Tremco Sealants & Coatings
- B. Silicone Sealant: Single component, air curing, non-staining, non-bleeding, capable of continuous water immersion, non-sagging type for application in vertical joints and in horizontal joints, color as selected.
- C. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- D. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- E. Joint Backing: ANSI/ASTM D1056; round, closed cell, polyethylene foam rod; oversized 30% to 50% larger than joint width.
- F. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
- G. Firestopping Materials and Systems:
 1. UL Listed products and assemblies.
 2. Subject to compliance with the requirements of Division 07.

2.12 ELECTRICAL WIRE

- A. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable.

- B. All wiring running exposed in return air plenums shall be plenum-rated cable for fire and smoke spread.

2.13 LOW VOLTAGE CONTROL WIRE AND CABLE

- A. All wiring materials section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable.
- B. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC, and General Purpose Cabling:
 - 1. Cable shall consist of copper conductors not less than #18 AWG stranded.
 - 2. Cable shall be two- or three-conductor twisted cable with a drain wire.
 - 3. Cable shall have a 100 percent overall shield.
 - 4. Cable shall be plenum rated.
 - 5. Cable shall meet or exceed NEC voltage rating of 300 volts.
 - 6. Cable shall be NEC type CMP.
 - 7. Cable shall meet or exceed UL temperature rating of +60 deg C.
- C. Primary and Secondary Communications Network Cabling:
 - 1. Cable shall be of type recommended by the DDC system manufacturer.
 - 2. Cable shall be shielded.
 - 3. Cable shall be plenum rated.
 - 4. Cable shall meet or exceed NEC voltage rating of 150 volts.
 - 5. Cable shall meet or exceed UL temperature rating of +60 deg C.

PART 3 - EXECUTION

3.1 GENERAL

- A. Fabrication, erection, and installation of the complete mechanical system shall be done by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up the progress of the project.
- B. The Contractor shall check all areas and surfaces where mechanical equipment or materials are to be installed and report any unsatisfactory conditions before starting work.
- C. Commencement of work signifies the Contractor's acceptance of the conditions as fit and proper for the execution of the mechanical work.
- D. Equipment and systems shall be installed in accordance with manufacturer's instructions, requirements, or recommendations.

3.2 DELIVERY AND STORAGE OF MATERIALS

- A. Take provisions for the delivery and safe storage of materials and shall make the required arrangements with other Contractors for the introduction into the building of equipment too large to pass through finished openings.
- B. Materials shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.
- C. Contractor shall be responsible for adequately protecting all supplies and equipment during cold weather.
- D. All items subject to cold weather damage shall be protected by covering, insulating, or storing in a heated space.

3.3 COOPERATION WITH OTHER CONTRACTORS

- A. Perform the work in conformance with the construction called for by other trades and afford other Contractors reasonable opportunity for the execution of their work.
- B. Properly connect and coordinate the mechanical work with the work of other Contractors at such time and in such a manner as not to delay or interfere with their work.
- C. Examine the contract documents for the General, Mechanical, and Electrical work and the work of other trades. Coordinate work accordingly.
- D. Promptly report to the Owner/Engineer any delay or difficulties encountered in the installation of the mechanical work which might prevent prompt and proper installation of work required from other trades.
- E. Systems Test and Balance Contractors or personnel shall coordinate their work with the contractors who installed the systems being tested or balanced.
- F. The Temperature Control Contractor or personnel shall be present during systems test and balance.

3.4 COORDINATION OF WORK

- A. The list below is the precedence of assigned work items for space priority in descending order. Items not listed shall have the same precedence as similar items.
 - 1. Reflected ceiling with all light fixtures, access above light fixtures required for maintenance, sprinkler head locations, and all ceiling fixtures and devices.
 - 2. Space designed for future utility placement.
 - 3. Gravity flow plumbing waste, roof drainage, and other systems that rely upon gravity for flow.
 - 4. Ductwork and appurtenances, except that external bracing shall be relocated to accommodate local interference.
 - 5. Fire sprinkler piping.
 - 6. Cable tray with access identification 8 inches horizontal to 6 inches above tray.
 - 7. Electrical conduit over 2 inches in diameter.
 - 8. HVAC piping except for pressurized domestic water piping.
 - 9. Plumbing vents.
 - 10. Electrical conduit under 2 inches in diameter.
- B. Plan all work so it proceeds with a minimum of interference with other trades.
- C. It shall also be the responsibility of the Mechanical Contractor to inform the Contractor of all openings required in the building construction for the installation of the mechanical work.
- D. The Contractor shall cooperate with all other contractors in furnishing material and information, in proper sequence, for the correct location of all sleeves, inserts, foundations, wiring, etc.
- E. Provisions shall be made for all special frames, openings, and sleeves as required.
- F. The Contractor shall pay for extra cutting and patching made necessary by his failure to properly direct such work at the correct time.

3.5 ELECTRICAL WIRING

- A. Install wiring in accordance with National Electric Code, ANSI/NFPA 70.

- B. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable. All wiring running exposed in air plenums shall be plenum cable.
- C. Install wiring (low and line voltage) in metal raceways or conduit unless inside control cabinet or unit enclosures.
 - 1. For concealed and accessible areas, plenum-rated wiring and cabling may be used.
- D. Low voltage wiring not installed in conduit shall be supported every five feet from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.
- E. Low voltage control wiring and 24 VAC can be run in the same conduit. Power wiring 120 VAC and greater must be in a separate conduit.
- F. Fastening shall be secured to walls or ceilings by means of appropriate screws, expansion screws anchors, toggle bolts, hollow wall screw anchors, nylon expansion anchors, or expansion shields. All-purpose plastic anchors are not acceptable.
- G. Locate circuits, relays, transformers, or other equipment that contains or must be connected to voltages exceeding 130 volts, in separate cabinets, which may be adjacent to control panels; permanently label "DANGER 277 VOLTS" or appropriate volts.
- H. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size shall be 3/4 inch.

3.6 CONTROL WIRING AND POWER CONNECTIONS

- A. Provide all incidental control power and wiring required to make the equipment or systems fully operational. Coordinate with equipment manufacture incidental wiring requirements.
- B. Unless indicated elsewhere, provide line voltage, 120VAC, 20 amp dedicated control power circuits and LAN outlet to each of the following and as indicated:
 - 1. BMCS Control panel, 1 circuit.
 - 2. Coordinate required 120V power circuits and LAN outlets with Electrical Contractor.
- C. Incidental control wiring includes but not limited to:
 - 1. Furnaces, Blower Coils, Water Source Heat Pumps, Air to Air Heat Pumps and Condensing Units
 - a. Provide 3/4 inch conduit with a minimum of eight distinctively colored or tagged #14 wires between units and remote panels or thermostats for control wiring
 - 2. HVAC Controls (Including but not limited to):
 - a. Manufacturer's Packaged Control Systems
 - b. Control Relays
 - c. Transmitters

3.7 LAYING OUT WORK

- A. Carefully lay out all work in advance of installation using data and measurements from the site, the appropriate architectural and structural drawings, and shop drawings.

- B. Equipment layout and all system layouts shall confirm adequate clearances for installation, operation, maintenance, and code-required clearances from the structure or other equipment and systems.
- C. Provide offsets and elevation changes in piping, conduit and ductwork as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
- D. The layout shall not cause problems of operation, maintenance, or clearance for items installed by other Contractors.
- E. Prior to installation of any work, make certain the location does not conflict with other items in or near the same location.
- F. If the layouts so prepared indicate that the required conditions cannot be met in the space provided, inform the Owner/Engineer prior to installation and shall request clarification.
- G. Failure to properly coordinate and lay out the work will require correction by the Contractors at their own expense.

3.8 DATA AND MEASUREMENTS

- A. Mechanical and electrical drawings are diagrammatic or schematic. Do not scale drawings.
- B. The data given herein and on the drawings is as accurate as could be secured; absolute accuracy is not guaranteed.
- C. Obtain exact locations, measurements, levels, etc., at the site and shall adapt their work to actual conditions.
- D. Examine the general construction, mechanical, electrical, and other applicable drawings and the Specifications.
- E. Only architectural drawings, structural drawings, and site measurements may be utilized in calculations.
- F. Layout and coordinate all work prior to installation to provide clearances for operation, maintenance and codes. Verify non-interference with other work.

3.9 POSITION OF DEVICES

- A. Locate devices mounted on finished surfaces with regard to paneling, furring, trim, etc. Where several devices occur in a room, they shall be symmetrically arranged as reviewed by the Owner/Engineer.
- B. Devices improperly located or installed shall be repaired, replaced or relocated at the Contractor's expense.
- C. Devices shall be set plumb or horizontal and shall extend to the finished surface of the wall, ceiling, or floor without projecting beyond the surface.
- D. Devices shown on wood trim, cases, or other fixtures shall be installed symmetrically and, where necessary, shall be set with the long dimension of the plate horizontal.
- E. Coordinate their respective devices so as not to destroy the aesthetic effect of the surface in which the devices are mounted.

- F. Coordinate the locations of all mechanical items with work furnished by other trades to avoid interference.
- G. If the required coordination is not done, the outlets or devices shall be removed and relocated if so directed by the Owner/Engineer and the damaged surfaces repaired at the Contractor's expense.
- H. Devices shall be installed at the height shown below unless otherwise noted. All heights of devices are measured from finished floor to centerline of device.
- I. Heights may be adjusted to correspond to nearest masonry course or as necessary to clear wall-mounted cabinets, fin tube convectors, unit heaters, etc.
 - 1. Temperature control panels: 60 inches
 - 2. Thermostats: 48 inches
 - 3. Carbon dioxide (CO2) sensors: 48 inches

3.10 PROTECTION OF APPARATUS

- A. Take such precautions as necessary to properly protect all apparatus, fixtures, appliances, material, equipment, and installations from damage of any kind.
- B. Failure to provide such protection to the satisfaction of the Owner/Engineer shall be sufficient cause for the rejection of any particular piece(s) of material, apparatus, equipment, etc., concerned.

3.11 ACCESS TO EQUIPMENT

- A. All motors, terminal boxes, valves, control devices, specialties, etc., shall be located to provide for easy access for operation, repair and maintenance; if concealed, access doors shall be provided.
- B. Access doors required for access to equipment requiring inspection or service shall be provided.
- C. Provide all access doors not already furnished by other Contractors but which are required for access to mechanical equipment.
- D. Doors shall be 12 inches by 12 inches unless shown otherwise.
- E. Person access doors shall be 18 inches by 18 inches minimum.

3.12 ROADWAYS, CURBS, AND WALKS

- A. Use every possible precaution to prevent injuries to roadways, curbs, and walks on or adjacent to the site of the work.
- B. Any damage shall be repaired at the Contractor's own expense. This shall also include damage necessary for installation of the mechanical work.

3.13 FRAMES

- A. Ducts passing through masonry walls shall be installed in steel angle iron frames and sleeves.
- B. All sleeves and frames shall be securely fastened to the walls. Provide for structural lintels in masonry wall openings.
- C. Ducts passing through openings in poured concrete walls and floors need not have frames.

3.14 FINISHED SURFACES PENETRATIONS

- A. All piping and ductwork penetrations of finished surfaces shall have escutcheons and/or closure plates.
- B. Openings shall be cut only as large as required for the installation, sleeves, and/or frames installed flush with finished surfaces and grouted in place.
- C. Surfaces around openings shall be left smooth and finished to match surrounding surface.
- D. Duct frames and pipe sleeves through floors in concealed locations and in unfinished spaces such as mechanical rooms, etc., shall extend 2 inches above finished floor level and shall be caulked watertight.
- E. All other sleeves shall extend approximately 1/4 inch above finished floor but shall allow placement of escutcheons.

3.15 FIRESTOPPING PENETRATIONS IN FIRE-RATED WALL/FLOOR ASSEMBLIES

- A. Subject to compliance with the requirements of Division 07.
- B. Provide proper sizing when providing sleeves or core-drilled holes to accommodate their work through penetrating items.
- C. All voids between sleeve or core-drilled hole and pipe passing through shall be firestopped to meet the requirements of ASTM E814.
- D. Install all materials complete, attached securely and permanently in place in accordance with manufacturers' printed directions.
- E. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- F. Do not cover installed firestopping until inspected by authority having jurisdiction.
- G. Install labeling required by code.

3.16 PIPING AND/OR DUCTWORK SYSTEMS - COMMON REQUIREMENTS

- A. General: Install as described below, unless individual Sections specify otherwise. Individual Sections specify unique installation requirements.
- B. General Locations and Arrangements:
 - 1. Drawing plans, schematics, and diagrams indicate general, diagrammatic location and arrangement of systems.
 - 2. Indicated locations and arrangements were used to size pipe or ductwork and calculate friction loss, expansion, pump and fan sizing, and other design considerations.
 - 3. Install systems as indicated, unless deviations to layout are approved on Coordination Drawings.
 - 4. Provide offsets and elevation changes in ductwork, piping and conduit as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
 - 5. Refer to architectural reflected ceiling plans for exact diffuser, register, grille, and ceiling mounted device locations.
 - 6. Do not run ductwork and piping above electrical panels or in code required clearance spaces.

7. Do not run ductwork, piping, and plumbing above or through information technology and data closets, IDF, and MDF rooms. Coordinate all routing with other trades.
8. Coordinate location of ductwork and piping with electrical cable tray. Provide a minimum of 6" of clear access above cable tray for installation of cables.
9. Install all horizontal ductwork and piping in mechanical rooms at a minimum of 7'-6" above finished floor.
10. Install exposed interior and exterior piping and ductwork at right angles or parallel to building walls.
 - a. Diagonal runs are prohibited, unless otherwise indicated.
11. Conceal ductwork and piping in walls, pipe chases, utility chases, above ceilings, below grade or floors, unless otherwise noted, except in mechanical rooms or service areas.
12. Install piping and ductwork to allow application of insulation plus 1-inch clearance around insulation.
13. Pipe hangers for insulated pipe with vapor barrier jackets shall be installed around the outside of the insulation and a metal insulation support shield provided to prevent crushing of the insulation.
14. Locate groups of pipes parallel to each other, spaced to permit insulation and valve servicing.
15. Dielectric nipples or flange insulation kits shall be utilized for all dissimilar pipe connections. Dielectric unions will not be accepted.
16. Install piping at indicated slope and as required by code.
17. Provide components with pressure rating equal to or greater than system operating pressure.
18. Install fittings for changes in direction and branch connections.
19. Install piping free of sags or bends with ample space between piping to permit proper insulation applications.
20. Install ductwork and piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building unless otherwise indicated.
 - a. Allow sufficient space above ceiling panels to allow for ceiling panel removal.
21. Install ductwork and piping to allow for expansion and contraction without stressing pipe, adjacent building structure or connecting equipment.
 - a. Provide expansion loops or compensators where indicated.
22. Do not use ceiling support system to bear weight of devices or systems unless ceiling support system is certified as suitable to do so.
23. During construction, avoid any undue loads, forces or strains on valves, equipment, pumps flanges, or building elements with piping connections or piping systems.
24. Keep all pipe, duct, and equipment openings closed during construction except when actual work is being performed on that item or system.
25. Leaking pipe and duct joints shall be remade using new materials.
26. Roof mounted piping, conduit and ductwork:
 - a. Coordinate all roof mounted support locations and loads with roofing contractor.
 - b. Space supports per all applicable codes and as indicated.
 - c. Provide 18" minimum under pipe, duct and conduit, to allow for roof repair.
27. Piping Penetrations:
 - a. Provide pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

- 1) Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2) Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3) Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4) Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5) Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- C. Contractor is responsible for any cutting and patching needed for mechanical installation. Patching must match existing.
- D. Size and route refrigerant piping per manufacturers' recommendations.
- E. Verify final equipment locations for roughing-in of all systems.
- F. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.17 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to manufacturer's requirements and submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Owner/Engineer.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components.
- E. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- F. Install equipment giving right of way to piping installed at required slope.
- G. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.18 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.19 GROUTING

- A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
 1. Clean surfaces that will come into contact with grout.
 2. Provide forms as required for placement of grout.
 3. Avoid air entrapment during placing of grout.
 4. Place grout, completely filling equipment bases.

5. Place grout on concrete bases to provide smooth bearing surface for equipment.
6. Place grout around anchors.
7. Cure placed grout according to manufacturer's written instructions.

3.20 INCIDENTAL WORK

- A. The following incidental work shall be furnished by the designated contractor under the supervision of the Temperature Control Contractor:
 1. The Piping Contractor shall install automatic valves and separable wells that are specified to be furnished by the Temperature Control Contractor.
 2. The Piping Contractor shall provide all necessary valved pressure taps, water, drain, and overflow connections and piping.
 3. The Piping Contractor shall provide all necessary piping connections required for flow devices, valve position indicators, etc.
 4. The Air Distribution Contractor shall install all automatic dampers furnished by the Temperature Control Contractor.
 5. The Air Distribution Contractor shall provide necessary blank-off plates (safing) required to install dampers that are smaller than duct size.
 6. The Electrical Contractor shall provide power wiring to the variable frequency drives.
 7. The Air Distribution Contractor shall assemble multiple section automatic dampers, furnished by the Temperature Control Contractor, with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper actuators.
 8. The Air Distribution Contractor shall provide necessary sheet metal baffle plates to eliminate stratification while providing air volumes specified. Locate baffles by experimentation and affix and seal permanently in place only after stratification has been eliminated.
 9. The Air Distribution Contractor shall provide access doors or other approved means of access through ducts for service to control equipment.
 10. Supply and return air motorized smoke dampers shall be provided by the Air Distribution Contractor on all air handling units 15,000 cfm and larger, as required by NFPA 90A, and shall be controlled by the Temperature Control Contractor. Dampers shall close when fan stops and open when fan starts.

3.21 EQUIPMENT AND SYSTEM SOFTWARE INTERFACES TO THE BMCS

- A. Contractor shall coordinate with the BMCS Contractor to determine the points that are to be mapped from the equipment and systems to the existing Trane BMCS. Contractor shall provide details of the method of integration and the information to be transferred between the systems as part of the submittal package.
- B. Contractor shall provide the necessary software communication ports specifically for the interfacing of the systems to the BMCS.
- C. Contractor cannot document that the exact same interface has been performed between the selected BMCS and the equipment and/or system, then the interfaces shall be tested prior to installations at an offsite location. The equipment shall not be installed at the project location until all software interfaces to the BMCS have been successfully demonstrated or documented.
- D. Documentation regarding the software interfaces shall be provided in sufficient detail as to enable a person reasonably skilled in the writing of real time software applications to add/delete points mapped from one system to the other. The documentation shall include a detailed description of each protocol used and the model, version and firmware details of any protocol converter (gateway) that is used.

- E. Refer to BMCS specifications for coordination and testing requirements.

3.22 LUBRICATION, TESTING AND TEST REPORTS

- A. Upon completion of the work, the entire system shall be tested and proven for capacity of equipment, balance of system, proper operation of controls, and comfort of conditioned spaces.
 - 1. Prior to beginning systems testing, adjusting and balancing, replace all filter media with new media.
 - 2. Test and balance procedures and documentation shall be in accordance with AABC, NEBB, or SMACNA unless indicated otherwise.
 - 3. Take air and water flow readings and submit copy of same to demonstrate proper flow according to the performances shown on the plans and noted in the specifications.
 - 4. Motors shall be checked for overload and belts adjusted.
 - a. Align pulleys and install belts according to manufacturer's written instructions.
 - b. Tension according to manufacturer's written instructions.
 - 5. Lubricate moving parts and clean or replace filters.
 - a. Run in all bearings and, after they are run in, drain and flush bearings and refill with a new oil charge.
 - b. Equipment shall be so arranged that tools (screwdrivers, wrenches, etc.) will not be required to make lubrication points accessible.
 - c. Extensions on grease or oil fittings shall be provided where required for access to lubricate.
 - 6. Smoke evacuation systems shall be tested in accordance with the requirements of the authority having jurisdiction and applicable codes and standards.
 - 7. Test piping systems per applicable codes and standards.
 - 8. Test ductwork systems per SMACNA and applicable codes and standards.
 - 9. Submit all test reports to the Owner/Engineer for review prior to date of substantial completion.
 - 10. Equipment and systems discrepancies shall be corrected prior to final acceptance.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.

1.2 REFERENCE STANDARDS

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.3 SUBMITTALS

- A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Product Data: Provide manufacturers catalog literature for each product required.
- C. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Control Panels: Nameplates.
- C. Heat Transfer Equipment, air cooled condensers: Nameplates.

2.2 MANUFACTURERS

- A. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
- B. Brady Corporation: www.bradycorp.com.
- C. Brimar Industries, Inc.: www.pipemarker.com.
- D. Champion America, Inc: www.Champion-America.com.
- E. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
- F. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
- G. Seton Identification Products: www.seton.com/aec.

2.3 NAMEPLATES

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

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners.
- B. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- C. Identify control panels and major control components outside panels with plastic nameplates.

3.3 NAME PLATES

- A. Install plastic name plates with stainless steel screws.
- B. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.
- C. Identify control panels and major control components outside panels with plastic nameplates.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.
- I. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- J. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- K. TAB: Testing, adjusting, and balancing.
- L. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- M. Test: A procedure to determine quantitative performance of systems or equipment.
- N. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.
- E. TABB - Testing, Adjusting, and Balancing Bureau.

1.4 SUBMITTALS

- A. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Owner/Engineer and for inclusion in operating and maintenance manuals.
 - 3. Provide reports in electronic, word searchable, .pdf format binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in I-P (inch-pound) units only.
 - 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Owner/Engineer.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
 - k. Certification sheet signed and sealed by the certified testing and balancing engineer.
- B. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Field test reports prepared by system and equipment installers.
 - 2. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

1.5 PROJECT CONDITIONS

- A. The entire TAB process shall be completed prior to Owner Occupancy.

1.6 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

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

1.7 WARRANTY

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

PART 2 PRODUCTS

2.1 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. SMACNA (TAB).
 - 3. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
- B. Examine equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- D. Examine system and equipment test reports.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- I. Examine equipment for installation and for properly operating safety interlocks and controls.
- J. Examine automatic temperature control and building automation system components to verify the following:
 - 1. Changeover from heating to cooling mode occurs according to indicated values.
 - 2. Transmitter and controller locations and note conditions that would adversely affect control functions.
- K. 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.

- L. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Owner/Engineer to facilitate spot checks during testing.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

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

3.6 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

- F. Check and adjust systems approximately six months after final acceptance and submit report.

3.7 AIR SYSTEM PROCEDURE

- A. Check for airflow blockages.
- B. Check condensate drains for proper connections and functioning.
- C. Check for proper sealing of air-handling unit components.
- D. Check for proper sealing of air duct system.
- E. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- F. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- G. Measure air quantities at air inlets and outlets.
- H. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- I. Adjusting:
 - 1. After installation, adjust diffusers, registers, and grilles to air patterns indicated, as directed and as required to prevent drafts before starting air balancing.
 - 2. Adjust air patterns per manufactures recommendations based on installed conditions.
- J. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- K. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- L. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- M. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

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

3.9 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Forced Air Furnaces.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
 - 7. Starter size, rating, heater elements.
 - 8. Sheave Make/Size/Bore.
 - 9. Motors Driven by Variable-Frequency Controllers:
 - a. Test for proper operation at speeds varying from minimum to maximum.
 - b. Test the manual bypass for the controller to prove proper operation.
 - c. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

- B. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.

1.2 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- F. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations. Show details for application of field-applied jackets.
- B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
- B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.
- D. Products shall be certified by UL GREENGUARD GOLD or Indoor Advantage Gold.
- E. Products shall certified to meet or exceed UL Standard 2818 -2013 Gold Standard for Chemical Emissions for Building Materials, Finishes and Furnishings
- F. Provide insulation thickness based on 2018 International Energy Conservation Code minimum requirements.
- G. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation; : www.jm.com.
 - 3. JP Lamborn Co: www.jpflex.com/#sle.
 - 4. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 5. Manson Insulation, Inc.: www.mansoninsulation.com
 - 6. Owens Corning Corp; : www.owenscorning.com.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. FSK: Kraft paper with glass fiber scrim yard and bonded to aluminized film; 0.0032 inch vinyl.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Aluminized foil film, with pressure sensitive acrylic based adhesive, 3 inches wide, 6.5 mils thick, 58-ounce force/inch adhesion, 23 lbf/inch tensile strength. Service temperature -40 - 250 degree F.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation; : www.jm.com.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 4. Manson Insulation, Inc.: www.mansoninsulation.com

5. Owens Corning Corporation: www.ocbuildingspec.com/sle.
- B. Insulation: ASTM C 612; rigid, noncombustible board.
 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Maximum Density: 8.0 pcf.
- C. Vapor Barrier Jacket:
 1. FSK: Kraft paper with glass fiber scrim yard and bonded to aluminized film; 0.0032 inch vinyl.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive, 3 inches wide, 6.5 mils thick, 90-ounce force/inch adhesion, 40 lbf/inch tensile strength.
- E. Indoor Vapor Barrier Finish:
 1. Manufacturers:
 - a. Fosters Model Vapor Out 30-33.
 - b. Childers Model Chil Out, CP-33.
 2. Cloth: Untreated; 9 oz/sq yd min. weight, glass fabric.
 3. Vinyl emulsion type acrylic, compatible with insulation, white color.
 4. Characteristics: 0.07 perm water-vapor permeance per ASTM E96, Procedure B at 45 mil dry film thickness; -20 degrees F to +180 degrees F temperature range; solid content, 55 percent by volume and 68 percent by weight per ASTM D 1644; white color.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated Ducts Conveying Air Below Ambient Temperature:
 1. Provide insulation with vapor barrier jackets, with minimum installed R-value of 6.0.
 2. Finish with tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated Ducts Conveying Air Above Ambient Temperature:
 1. Provide with or without standard vapor barrier jacket, with minimum installed R-value of 6.0.
 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

- E. External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 5. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - c. 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:
 - 1) 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.
 - 2) 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.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) Impale insulation over pins and attach speed washers.
 - 6) 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.
 - d. 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.
 - 1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor barrier seal.
 - 2) Install vapor stops for ductwork and plenums operating below 50 degrees 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.
 - e. 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.
 - f. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface.

- g. 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.
6. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transition.
 - c. 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:
 - 1) 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.
 - 2) 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.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) 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.
 - d. 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.
 - 1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor barrier seals.
 - 2) Install vapor stops for ductwork and plenums operating below 50 degrees 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.
 - e. 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.
 - f. 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.

3.3 DUCT INSULATION

- A. Provide insulation thickness based on 2018 International Energy Conservation Code minimum requirements.

- B. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- C. Items Not Insulated:
 - 1. Metal ducts and plenums with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.

3.4 INSULATION AND JACKET SCHEDULE

- A. Indoor Duct and Plenum
 - 1. Supply Air:
 - a. Concealed, supply-air duct insulation shall be any of the following:
 - 1) Glass-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 2) Glass-Fiber Board: 2 inchesthick and 2-lb/cu. ft.nominal density.
 - b. Concealed, supply-air plenum insulation shall be any of the following:
 - 1) Glass-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
 - 2. Return Air:
 - a. None.
 - 3. Outdoor Air:
 - a. Concealed, outdoor-air duct insulation shall be any of the following:
 - 1) Glass-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 2) Glass-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
 - b. Concealed, outdoor-air plenum insulation shall be any of the following:
 - 1) Glass-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft.nominal density.

END OF SECTION

SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, specialties and connections for natural gas piping systems.

1.2 REFERENCE STANDARDS

- A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators.
- B. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators.
- C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- E. ASME B31.1 - Power Piping.
- F. ASME B31.9 - Building Services Piping.
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- I. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
- J. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
- K. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
- L. ICC-ES AC106 - Acceptance Criteria for Pre drilled Fasteners (Screw Anchors) in Masonry Elements.
- M. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
- N. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Project Record Documents: Record actual locations of valves.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.

- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- E. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.2 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.
- B. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 6. Other Types: As required.

2.4 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

- A. Compliance Requirements:
 - 1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
 - 2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.
- B. Materials in Contact With Gas:
 - 1. Housing: Aluminum, steel (free of non-ferrous metals).
 - 2. Seals and Diaphragms: NBR-based rubber.

- C. Maximum Inlet Operating Pressure: 10 psi.
 - 1. Appliance Regulator: 10 psi.
 - 2. Line Pressure Regulator: 10 psi.
- D. Maximum Body Pressure: 10 psi.
- E. Output Pressure Range: 1 inch wc to 80 inch wc.

2.5 GAS SPECIALTIES:

- A. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Establish elevations of buried piping outside the building to ensure not less than _____ ft of cover.
- J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Section _____.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.

- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
- N. Install valves with stems upright or horizontal, not inverted.
- O. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- P. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813.
- Q. Sleeve pipes passing through partitions, walls and floors.
- R. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Provide plug valves in natural gas systems for shut-off service.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ducts.
- B. Flexible ducts.

1.2 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C168. In this Section, these values are the result of the formula $Btu \times in./h \times sq. \text{ ft.} \times deg \text{ F}$ or $W/m \times K$ at the temperature differences specified. Values are expressed as Btu or W.
 - 1. Example: Apparent Thermal Conductivity (k-Value): 0.25 or 0.037.
- B. Pressure - Velocity Classification for Ductwork: As defined by SMACNA Duct Construction Standards - Metal and Flexible (latest edition), and applicable codes. Pressure classification for this specification:
 - 1. Low Pressure: Maximum 2500 FPM velocity; maximum 2.0 inches WG positive or -2.0 inches WG negative static pressure class.
 - 2. Medium Pressure: Maximum 4000 FPM velocity; maximum 4 inches WG positive or -3.0 inches WG or greater negative static pressure class.
 - 3. High Pressure: Velocity over 4000 FPM, pressure over 4 inches WG.
- C. Gauge:
 - 1. Steel Sheet: U.S. Standard gauge.
 - 2. Aluminum Sheet: Brown & Sharpe schedule.
 - 3. Steel Wire: Washburn & Moen gauge.
- D. Concealed Insulated Surfaces: Ductwork and equipment located in walls, partitions, floors, chases, shafts, and above ceilings.
- E. Exposed Insulated Surfaces: Ductwork and equipment located in mechanical rooms, tunnels and rooms without suspended ceilings.

1.3 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- F. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

1.4 PERFORMANCE REQUIREMENTS

- A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Design Professional. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.
- B. Size round ducts in lieu of rectangular ducts indicated in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

- A. Product Data: Provide data for all duct materials and duct connections.
- B. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
- C. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members, and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- D. Comply with ASHRAE and SMACNA Design Handbooks.

1.7 FIELD CONDITIONS

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

1.8 DELIVERY, STORAGE AND HANDLING

- A. Ductwork shall not be stored directly on the ground. Watermarked ductwork will not be accepted for installation.
- B. Lined ductwork shall have all open ends sealed during delivery and storage periods.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Duct Shape and Material in accordance with Allowed Static Pressure Range:
 - 1. Round: Plus or minus 2 in-wc of galvanized steel.
 - 2. Rectangular: Plus or minus 1/2 in-wc of galvanized steel.
- C. Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
 - a. Low Pressure Supply: 1 inch w.g. pressure class, galvanized steel.
 - b. Supply Air: 1/2 in-wc pressure class, galvanized steel.
 - c. Outside Air Intake: 1/2 in-wc pressure class, galvanized steel, liquid tight joints on horizontal routes.
 - d. Return and Relief Air: 1 in-wc pressure class, galvanized steel.
 - e. Combustion Air: 1 inch w.g. pressure class, galvanized steel.
- D. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 3. Construct tee's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
 - 4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
 - 5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
 - 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
 - 1. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Water based, non-fibrated, heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Duct Sealing Rolled Sealant:
 - a. Pressure sensitive, 40-year cycle, duct joint and general purpose rolled sealant. rated for use with sheet metal, duct board, flex board, PVC coated duct, and duct wrap vapor barriers.
 - b. 100 percent solid elastomeric modified butyl with aluminum foil backing.

- c. Thickness: 17 Mils.
- 3. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel, threaded steel rod or steel cable with adjustable and removable locking mechanism.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap, Rod and Cable Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and steel rod diameters. Comply with SMACNA and manufacturer's recommendations for cable and locking mechanism sizes.
- C. Cable Hanger System:
 - 1. Basis of Design: Gripple and Ductmate Clincher
 - 2. Products shall carry a 5:1 safety factor.
 - 3. SMACNA compliance - Tested and verified to be an acceptable hanger per the SMACNA, HVAC Duct Construction Standards.
 - 4. UL Listing - UL 1598 luminaire fitting sizes 1 - 5, UL 2289 Conduit and Cable Hardware sizes 2, 3 and 4.
 - 5. Housing: Type ZA2 Zinc.
 - 6. Wedge: Sintered steel hardened to min. 56 Rockwell C.
 - 7. Spring: 302 Stainless Steel.
 - 8. End Cap: UV stabilised homopolymer propylene.
 - 9. Wire Rope: Grade galvanized high tensile steel wire rope to EN12385.
 - 10. Toggle Plate and End Stop: Zinc plated steel.
 - 11. Stud Eyelet and Barrel End: Zinc plated steel.
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.
- F. Flexible Duct Elbow Supports:
 - 1. Universal-mount, 1-piece, fully adjustable, radius-forming brace to support 4-inch through 16-inch diameter flexible air ducts.
 - 2. Classified: UL 2043.
 - 3. Material: 100 percent recycled copolymer polypropylene.
 - 4. Support Frame Radius: 8 inches.

5. Compliance for Flexible Duct Radius:
 - a. SMACNA HVAC Duct Construction Standards.
 - b. ASHRAE Advanced Energy Design Guides.
 - c. ADC Flexible Duct Performance and Installation Standards.
6. Basis of Design: FlexRight (Durable Elbow Support)

2.4 DUCTWORK FABRICATION

- A. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation. Radius T's, bends and elbows less than 1-1/2 times width of duct on centerline are not allowed.
- B. Low Pressure Ductwork: Construct all ductwork using galvanized steel except as indicated.
 1. Seams and Joints: Longitudinal seams shall be grooved seams, button punch snap lock or Pittsburgh lock. Transverse joints shall be drive slip. Joints 36-inch size and larger shall be manufactured duct joining system with downset corners, no-bolt design, or SMACNA T-25 formed on flanges with corner and cleat. Contractor option on smaller sizes.
- C. Branch ducts to air devices shall be bell-mouth, conical or 45 degrees to round boot type fitting as a basis. Straight tap-ins, splitter dampers, and air extractors shall not be used.
- D. Duct connections to fans/air-handling units shall be designed for proper entering and leaving conditions at the fan to avoid any adverse system effect fan losses.

PART 3 EXECUTION

3.1 PRE-INSTALLATION

- A. Field measure to determine exact conditions.
- B. Provide duct opening closure film on all ductwork until final connections are completed.
- C. Verify location of air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to reflected ceiling plans, finish schedule, material finish specification, and shop drawings.
- D. Openings required for ductwork through structural elements in new construction shall be coordinated with the General Contractor. Shop drawings locating such openings shall be prepared in ample time to meet the construction schedule.
- E. Coordinate and install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts with a clearance of 2 inches, plus allowance for insulation thickness.
- F. Coordination Process and Drawings:
 1. Provide coordination in determining adequate clearance and space requirements for mechanical equipment and electrical equipment and other items/equipment in the project. The Design Professional reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Design Professional will only review conflicts and given an opinion but will not perform as a coordinator.
 - a. The coordination process shall utilize the actual equipment being provided. Refer to manufacturer's data for physical size, access and maintenance requirements. Provide all code required clearances.

2. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.
3. Equipment layout and all system layouts shall confirm adequate clearances for installation, operation, maintenance, and code-required clearances from the structure or other equipment and systems. Provide offsets and elevation changes in piping, conduit and ductwork as required to complete the Layout and Coordination Process. Offsets and elevation change information shall be indicated in the coordination process documentation and must be submitted for review.
4. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Design Professional.
5. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:
 - a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.
 - b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.
 - c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.
6. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Design Professional and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Design Professional and the Owner.
7. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Design Professional revisions necessary to the work of others not directly affected by the change order.
8. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

3.2 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
 1. Hanging, Sealing and Supporting:
 - a. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
 - b. Support vertical ducts at a maximum interval of 16 feet and at each floor.
 - c. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
 - d. Install concrete inserts before placing concrete.

- e. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1) Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - f. Seal ducts before external insulation is applied.
- B. Install products following the manufacturer's instructions.
- C. Comply with safety standards NFPA 90A and NFPA 90B.
- D. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Keep openings covered until ready for continuing duct run or final connections. Clean all unlined supply air ductwork during installation by swabbing with a non-toxic, non-flammable cleaning agent.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Provide volume dampers in all duct systems where indicated and as required to perform complete system test and balance. Coordinate all volume damper locations with the test and balance contractor.
 - 1. Provide access door or remote damper operator to adjust dampers.
- G. Duct sizes indicated are inside precise dimensions. For lined ducts, maintain sizes inside lining.
- H. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
- I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- J. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with a crimp in the direction of airflow.
- K. Use double nuts and flat washer on threaded rod supports.
- L. Connect terminal unit inlets to supply ducts directly or with one foot maximum length of straight run of flexible duct. Do not use flexible duct to change direction.
- M. Plenums and Casings:
 - 1. Mount floor-mounted casings on 4 inch high concrete curbs.
 - 2. Where floors are acoustically insulated, provide liner of galvanized 18 gauge, 0.052 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- N. Fire Partitions: Provide firestopping sealing as indicated within Section 07 84 00.
- O. Penetrations:
 - 1. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

2. Provide sleeves at all duct penetrations through walls, floors and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for full thickness of wall.
 3. Provide closure flanges around exposed ductwork at wall and ceiling penetrations, 1-1/4 inches wide minimum.
- P. Install round and flat-oval ducts in lengths not less than 12 feet, unless interrupted by fittings.
- Q. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- R. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- S. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- T. Prevent passage of unfiltered air around filters with felt, rubber, neoprene gaskets, or other approved safing material.
- U. Paint ductwork visible behind wall-mounted air outlets and inlets matte black.
- V. Provide flexible connect between ductwork and all moving equipment.

3.3 DUCT LEAKAGE TESTING

- A. General: Perform duct leakage testing to assure that duct construction and joint sealing methods have been followed.
1. Submit leakage test on SMACNA "Air Duct Leakage Test Summary" report form as found in SMACNA "HVAC Air Duct Leakage Test Manual, 2012.
 2. Form shall be completed in full, signed by individual performing the test, and witnessed by the General Contractor.
- B. Conduct tests at static pressure equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure.
- C. Ductwork minimum seal and leakage classes shall conform to applicable energy code requirements.
- D. Duct Leakage Test Criteria - Low Pressure Metal Duct:
1. Duct pressure class: 1/2 - 2 inches wg
 2. Seal class: B
 3. Seal scope: Transverse joints and longitudinal seams
 4. Leakage class:
 - a. Rectangular Metal: 8
 - b. Round or Oval Metal: 4

END OF SECTION

SECTION 23 54 00

FURNACES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Forced air furnaces.
- B. Thermostats.

1.2 REFERENCE STANDARDS

- A. ANSI Z21.47 - American National Standard for Gas-Fired Central Furnaces.
- B. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.[]
- C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ASHRAE Std 103 - Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.
- F. NEMA MG 1 - Motors and Generators.
- G. NFPA 54 - National Fuel Gas Code.
- H. NFPA 70 - National Electrical Code.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- J. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- K. UL (DIR) - Online Certifications Directory.

1.3 SUBMITTALS

- A. Specification Compliance Review.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

- G. Project Record Documents: Record actual locations of components and connections.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Filters: One for each furnace.
 - 3. Extra Pilot Thermocouples: One.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience and approved by manufacturer.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturers warranty for solid state ignition modules.
- C. Provide five year manufacturers warranty for heat exchangers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Corporation, : www.carrier.com.
- B. Trane Inc, : www.trane.com.
- C. York International Corporation / Johnson Controls: www.york.com.

2.2 REGULATORY REQUIREMENTS

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

2.3 GAS FIRED FURNACES

- A. Annual Fuel Utilization Efficiency (AFUE): 0.95 ("condensing") in accordance with ASHRAE Std 103.
- B. Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating element, controls, air filter and accessories; wired for single power connection with control transformer.
 - 1. Safety certified by CSA in accordance with ANSI Z21.47.
 - 2. Venting System: Direct.
 - 3. Combustion: Indoor Air.
 - 4. Air Flow Configuration: Upflow, downflow or horizontal, refer floor plan for configuration. As indicated.
 - 5. Heating: Natural gas fired.
 - 6. Accessories:
 - a. Condensate drain.

- C. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner. If not certified for combustible flooring, please provide additional steel base.
- D. Primary Heat Exchanger:
 - 1. Material: Aluminized steel.
 - 2. Coating: Ceramic.
 - 3. Shape: Tubular type.
- E. Gas Burner:
 - 1. type with adjustable combustion air supply,
 - 2. Gas valve, two stage provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 - 3. Electronic pilot ignition, with electric spark igniter.
 - 4. Combustion air damper with synchronous spring return damper motor.
 - 5. Non-corrosive combustion air blower with permanently lubricated motor.
- F. Gas Burner Safety Controls:
 - 1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - 2. Flame rollout switch: Installed on burner box and prevents operation.
 - 3. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
 - 4. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic resets.
- G. Supply Fan: Centrifugal type rubber mounted with direct drive.
- H. Motor:
 - 1. 1750 rpm single-speed, permanently lubricated, hinge mounted.
- I. Air Filters: 1 inch thick glass fiber, disposable, pleated type arranged for easy replacement. Provide filter compartment, rails for downflow and upflow Units. At upflow and down flow units with side return air connection, provide filter box at connection to furnace.
- J. Operating Controls:
 - 1. Room Thermostat: Cycles burner to maintain room temperature setting.
 - 2. Supply Fan Control: Energize from bonnet temperature independent of burner controls, with adjustable timed off delay and fixed timed on delay, with manual switch for continuous fan operation.
 - 3. Digital thermostat shall connect to the existing Trane SC campus wide Building Automation system, no exceptions. Thermostat shall communicate directly with the building automation system to provide time of day on/off, heating /cooling scheduling and setpoint adjustment.

2.4 COOLING FEATURES

- A. Evaporator Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Match remote condensing unit specified in Section 23 6213 - Packaged Air-Cooled Refrigerant Compressor and Condenser, with type, capacity, pressure-drop ratings, restricted distributor, or expansion valve. Include condensate drain pan with accessible drain outlet.

- B. Evaporator Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
- C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, and sealed. Insulate suction line with minimum 3/8-inch-thick, flexible elastomeric tubular insulation complying with ASTM C 534, Type I. Flared or sweat ends compatible with coil and condensing unit connections.

2.5 COMBUSTION AIR AND FLUE VENT MATERIALS

- A. Type B, double wall, indner wall aluminum, outer wall galvanized steel, same size as flue vent connectionat furnace with weather cap.

2.6 THERMOSTATS

- A. Room Thermostat: Low voltage, digitally communicating, electric solid state microcomputer based room thermostat:
 1. System selector switch (heat-off) and fan control switch (auto-on).
 2. Preferential rate control to minimize overshoot and deviation from setpoint.
 3. Instant override of setpoint for continuous or timed period from one hour to 31 days.
 4. Short cycle protection.
 5. Battery replacement without program loss.
 6. Digital communicating wtih existing Trane Campus Automation System (no exceptions). Control sequence to provide; On/Off Scheduling and heating / cooling setpoint adjustment.
 7. Thermostat Display:
 - a. Duration of timed override.
 - b. Day of week.
 - c. System Mode Indication: Heating, cooling, fan auto, off, and on, auto or on, off.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and located correctly.
- C. Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of authorities having jurisdiction.
- B. Install in accordance with NFPA 90A.
- C. Install gas fired furnaces in accordance with NFPA 54.
- D. Provide vent connections in accordance with NFPA 211.
- E. Mount counterflow furnaces installed on combustible floors on additive base.
- F. Pipe drain from humidifier to nearest floor drain and connect to domestic water.

- G. Controls: Install thermostats and humidistats at mounting height of 54 inches above floor.
- H. Control Wiring: Wiring to thermostat(s) and humidistat(s) shall be by Mechanical Contractor.
- I. Power Wiring: All power wiring and control wiring to condensing unit(s) shall be by Electrical Contractor.
- J. Identify furnaces according to Section 23 0553 - Identification for HVAC Piping and Equipment.
- K. Vent and Outside-air Connection, Gas-fired Furnaces: Double wall type B gas vent, inner wall material aluminum, outer wall - galvanized steel. Connect flue vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt, in accordance with manufacturer's recommendations.
- L. Connect ducts according to Section 23 3100 - HVAC Ducts and Casings.
- M. Install piping adjacent to machine to allow service and maintenance.

END OF SECTION

SECTION 23 62 13

PACKAGED AIR OR WATER COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Condensing unit package.

1.2 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 365 (I-P) - Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units.
- C. ASHRAE Std 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ASHRAE Std 90.2 - Energy-Efficient Design of Low-Rise Residential Buildings.
- F. NEMA MG 1 - Motors and Generators.
- G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.3 SUBMITTALS

- A. Specification Compliance Review.
- B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Include equipment served by condensing units in submittal, or submit at same time, to ensure capacities are complementary.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.
- D. Design Data: Indicate pipe and equipment sizing.
- E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- F. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty on Compressor, Motor and Drive Trains: Written warranty, signed by manufacturer, agreeing to repair or replace compressor, motor, and drive train, including replacement of refrigerant parts and labor.
- C. Provide a five year warranty to include coverage for refrigerant compressors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carrier, a part of UTC Building and Industrial Systems, a unit of United Technologies Corp: www.carrier.com.
- B. Trane, a brand of Ingersoll Rand: www.trane.com.
- C. York International Corporation/Johnson Controls, Inc: www.york.com.

2.2 PERFORMANCE REQUIREMENTS

2.3 MANUFACTURED UNITS

- A. Units: Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.
- B. Construction and Ratings: In accordance with AHRI 210/240. Test in accordance with ASHRAE Std 23.1.
- C. Construction and Ratings: In accordance with ARI 210/240. Testing shall be in accordance with ASHRAE Std 23.
- D. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 I-P.

2.4 CASING

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
- B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.
- C. Provide removable access doors or panels with quick fasteners and piano hinges.

2.5 AIR-COOLED CONDENSER COILS

- A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig, and vacuum dehydrate. Seal with holding charge of nitrogen.
- B. Coil Guard: Expanded metal.

2.6 FAN REQUIREMENTS

- A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Equip with roller or ball bearings with grease fittings extended to outside of casing.
- B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection.

2.7 COMPRESSORS

- A. Compressor: Hermetic scroll type or semi-hermetic screw type.
- B. Mounting: Statically and dynamically balance rotating parts and mount on spring vibration isolators.
- C. Lubrication System: Reversible, positive displacement oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.
- D. Motor: Constant speed 1800 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting.
 - 1. Furnish with starter, see Section 23 05 13.

2.8 REFRIGERANT CIRCUIT

- A. For each refrigerant circuit, provide:
 - 1. Filter dryer replaceable core type.
 - 2. Liquid line sight glass and moisture indicator.
 - 3. Thermal expansion valve for maximum operating pressure.
 - 4. Insulated suction line.
 - 5. Suction and liquid line service valves and gauge ports.
 - 6. Liquid line solenoid valve.
 - 7. Charging valve.
 - 8. Discharge line check valve.
 - 9. Compressor discharge service valve.
 - 10. Condenser pressure relief valve.
- B. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.9 CONTROLS

- 1. Low suction pressure switch (automatic reset) for each compressor.
- A. Provide the following operating controls:
 - 1. Thermostat located in room cycles compressors upon call for cooling.
 - 2. Five minute off timer prevents compressor from short cycling.
- B. Provide controls to permit operation down to 0 degrees F ambient temperature.

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 condensing units.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Install roof-mounting units on equipment supports.
- C. Vibration Isolation: Mount condensing units on rubber pads with a minimum deflection of 1/4 inch. Vibration isolation devices and installation requirements are specified in Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Maintain manufacturer's recommended clearances for services and maintenance.
- E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
- F. Install in accordance with manufacturer's installation instructions.
- G. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.
- D. Ground equipment according to Division 26.
- E. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical test and visual and mechanical inspection.
 - 2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
 - C. Remove and replace malfunctioning condensing 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 perform the following:
 1. Inspect for physical damage to unit casing.
 2. Verify that access doors move freely and are weathertight.
 3. Clean units and inspect for construction debris.
 4. Verify that all bolts and screws are tight.
 5. Adjust vibration isolation and flexible connections.
 6. Verify that controls are connected and operational.
- C. Lubricate bearings on fans.
- D. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
- E. Adjust fan belts to proper alignment and tension.
- F. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
- G. Measure and record airflow over coils.
- H. Verify proper operation of condenser capacity control device.
- I. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- J. After startup and performance test, lubricate bearings and adjust belt tension.

END OF SECTION

SECTION 26 04 00
COMMON REQUIREMENTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY

- A. This section describes the general requirements of these specifications and shall apply to all phases of the work specified, shown on the drawings, or required to provide for complete installation of all systems for this project.
- B. This Section includes basic materials and methods to complement other Division 26 Sections.
- C. This Section includes basic materials and methods to complement Section 28 46 00 - Fire Detection and Alarm.

1.2 WARRANTIES

- A. Warrant materials, workmanship and equipment against defects for a period of one year after the date of substantial completion.
- B. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those divisions of the Project Manual.
- C. Repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period.
- D. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner.
- E. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project.
- F. The repair of faulty workmanship shall be considered to be included in the contract.

1.3 QUESTIONS OF INTERPRETATION DURING BIDDING PHASE

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Owner/Engineer for clarification.
- B. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date.
- C. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents.
- D. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- E. The Owner/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.4 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, request clarification from the Owner/Engineer before proceeding with the work.

- B. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Owner/Engineer.
- C. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Owner/Engineer was requested and obtained before submission of proposed methods or materials.
- D. The Owner/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 DEFINITIONS

- A. The following definitions shall apply throughout the contract documents:
 1. Owner/Engineer: Architect or Engineer
 2. Code: Applicable national, state and local codes
 3. Mechanical: Plumbing and HVAC work required by the Contract Documents
 4. Electrical: Electrical work required by the Contract Documents
 5. Contractor: Any Contractor performing work required by the Contract Documents
 6. Indicated: Noted, scheduled or specified
 7. Selected: Selected by the Owner/Engineer.
 8. Provide: Furnish, install, connect and tested complete and ready for use
 9. Furnish: Supply and deliver to the site ready for installation
 10. Install: Install complete, per Contract Documents and manufacturer's requirements.
 11. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 12. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
 13. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
 14. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
 15. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 16. Dry Locations: A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.
 17. Damp Locations: Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.
 - a. Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold storage warehouses.
 18. Wet Locations: Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 SYMBOLS

- A. Items of equipment and materials are indicated on the drawings in accordance with the symbols on the plans.

1.7 ABBREVIATIONS

- A. Refer to abbreviations list on the Drawings.
- B. The following abbreviations apply throughout the Contract Documents:
 - 1. ADA: Americans with Disabilities Act
 - 2. ANSI: American National Standards Institute
 - 3. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 4. ASME: American Society of Mechanical Engineers
 - 5. ASTM Specification: Standard specifications of the American Society for Testing Materials
 - 6. FM: Factory Mutual Engineering Corporation
 - 7. IRI: Industrial Risk Insurers
 - 8. NEC: National Electrical Code, latest edition
 - 9. NEMA: National Electrical Manufacturers Association
 - 10. NFPA: National Fire Protection Association
 - 11. UL or Underwriters: Underwriters Laboratories, Inc.

1.8 CODES

- A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards.
- B. The work shall conform to all applicable sections of currently adopted editions of the following codes, standards, and specifications:
 - 1. International Building Code (IBC)
 - 2. International Fire Code (IFC)
 - 3. International Energy Conservation Code (IECC)
 - 4. Safety and Health Regulations for Construction
 - 5. Occupational Safety and Health Standards (OSHA), National Consensus Standards and Established Federal Standards
 - 6. National Electrical Code (NEC)
 - 7. National Electrical Safety Code (NESC)
 - 8. National Fire Protection Association (NFPA)
 - 9. Life Safety Code (NFPA 101)
 - 10. Factory Mutual Global Engineering (FMG)
 - 11. Underwriters' Laboratories, Inc. (UL)
 - 12. National Electrical Manufacturers Association (NEMA)
 - 13. Institute of Electrical and Electronics Engineers (IEEE)
 - 14. Insulated Power Cable Engineers Association (IPCEA)
 - 15. Telecommunications Industry Association (TIA)
 - 16. Building Industry Consulting Service International (BICSI)
 - 17. Applicable national, state and local codes
- C. Where there is a conflict between the code and the Contract Documents, the code shall have precedence only when it is more stringent than the Contract Documents.
 - 1. Items that are allowed by the code but are less stringent than those specified shall not be substituted.

1.9 PERMITS

- A. The Contractors shall familiarize themselves with requirements regarding permits, fees, etc., and shall comply with them.
- B. Permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.
- C. Utilities shall be installed in accordance with the local rules and regulations. Charges shall be paid by the Contractor.

1.10 MATERIALS AND EQUIPMENT MANUFACTURERS

- A. Options in selecting materials and equipment are limited by requirements of the contract documents and governing regulations. They are not controlled by industry traditions or procedures experienced on previous construction projects.
- B. Materials and equipment shall be provided in accordance with the following:
 - 1. Primary Design Products: Primary design products are those products around which the project was designed in terms of capacity, performance, physical size and quality.
 - 2. Primary design products are indicated by use of a single manufacturer's name, model number or similar data on drawings or schedules or within the specifications.
 - 3. Provide primary design products unless substitutions are made in accordance with the following paragraphs.
 - 4. Acceptable Equivalent Substitutions: Acceptable equivalent substitutions are products of manufacturers other than those listed for the primary design products. Equivalent acceptable substitutions shall meet each of the following requirements:
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the Project Manual, drawings, or addenda.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance, and physical characteristics.
 - c. The Contractor providing the substitution shall bear the total cost of changes due to substitutions. These costs may include additional compensation to the Owner/Engineer for redesign and evaluation services, increased cost of work by the Owner or other Contractors, and similar considerations.
 - 5. Performance Requirements: Where the contract documents list performance requirements or describe a product or assembly generically, provide products that comply with the specific requirements indicated and that are recommended by the manufacturer for the respective application.
 - 6. Compliance with Standards, Codes and Regulations: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including the standards, codes and regulations.
- C. Proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, delivery time requirements, and the availability of repair or replacement parts may also be considered.
- D. The Owner/Engineer shall be the sole and final judge as to the suitability of substitution items.

1.11 SUBMITTALS

- A. Shop Drawings, Product Data and Samples:
1. Other sections in the Project Manual shall be adhered to if more stringent than the following paragraphs.
 2. When required by other sections of this Project Manual, submit shop drawings, product data or samples to the Owner/Engineer for review.
 3. Submittals deemed unnecessary by the Owner/Engineer shall be returned indicating "No Action Taken".
 4. A completed copy of the transmittal form included with the Project Manual shall accompany each submittal.
 5. Submittals shall be numbered consecutively.
 6. Unless otherwise noted, submit one copy electronically of shop drawings and product data for review. Review comments will be returned electronically. A hard copy of the electronic submittal will be returned if requested.
 7. Where samples are required, submit one (1) sample of each required item.
 8. Shop drawings are drawings, diagrams, schedules and other data specifically prepared for this project by the Contractor, Manufacturer, Supplier, or Distributor to illustrate some portion of the work. Shop Drawings shall also detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
 - a. Shop drawings shall be drawn to accurate scale and of adequate size to illustrate required details.
 9. Product data are illustrations, standard schedules, performance charts, instruction brochures, diagrams and other information furnished by the Contractor, Manufacturer, Supplier, or Distributor to illustrate a material, product or system for some portion of the work.
 10. Samples are physical examples furnished by the Contractor, Manufacturer, Supplier, or Distributor to illustrate materials, equipment or workmanship and to establish the standards by which the work will be performed.
 11. Each submittal shall clearly indicate proposed items, capacities, characteristics and details in conformance with contract documents. Equipment items shall be marked with the same item number as used on drawings or schedules. Capacities, dimensions and special features required shall be certified by the manufacturer.
 12. Submittals shall indicate manufacturer's delivery time for the item after review by the Owner/Engineer.
 13. When required by other sections of this Project Manual, the Contractor shall submit a Specification Compliance Review consisting of a paragraph-by-paragraph review of the specifications and addenda with the following marked for each paragraph. Markings may be made in the margins of the original specification or addenda. Unless a deviation or exception is specifically noted in the Specification Compliance Review, it is assumed that the equipment, product, or material is in complete compliance with the contract documents. Submit Specification Compliance Review with shop drawings and product data.
 - a. "C": Comply with no exceptions.
 - b. "D": Comply with minor deviations. For each deviation, provide the reasons for the deviation and how the intent of the specification can be satisfied.
 - c. "E": Exception. Equipment, product, or material does not comply. For each exception, provide reasons for the exception, and suggest possible alternatives for the Owner's consideration.
 - d. "N/A": The paragraph does not apply to the proposed equipment, product, or material.

14. The Owner/Engineer shall review or take other appropriate action upon the Contractor's submittals such as shop drawings, product data and samples, but only to determine conformance with the design concept of the work and the information given in the contract documents.
 15. Contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Owner/Engineer's review of shop drawings, product data or samples.
 16. Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Owner/Engineer's review of those drawings.
 17. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Owner/Engineer. Such portions of the work shall be in accordance with reviewed submittals.
 18. The successful Contractor/Supplier may, at their option, obtain DXF or AutoCad DWG electronic drawing files for use in preparation of shop drawings.
 - a. This information is available from Alvine Engineering upon written request.
 - b. A non-refundable handling charge of \$10.00 per drawing file requested will be required at the time of receipt of the electronic files.
 - c. The use of these drawing files is intended solely for the preparation of drawings as required by these contract documents.
 - d. Any other use is strictly prohibited by copyright laws.
 - e. The user of these electronic drawing files assumes full responsibility for their accuracy and scale.
- B. Operation and Maintenance Manuals:
1. Prepare three (3) operation and maintenance manuals for the equipment furnished. Manuals shall be submitted to the Owner/Engineer for review and distribution to the Owner not less than 30 days prior to substantial completion of the project. Manuals not meeting the following requirements may be rejected by the Owner/Engineer.
 2. Each manual shall be assembled in a three-ring binder with hard cover and plastic finish. Binders shall not exceed a 3-inch thickness. Where more than one binder is required, the manuals shall be separated into a logical grouping, i.e., "Mechanical", "Electrical", "Maintenance", "Operation", "Parts", "Shop Drawings", etc. Each binder shall have the following information clearly printed on its front cover:
 - a. Project name and address.
 - b. Portion of the work covered by each volume (if more than one volume in the set). Where more than one volume is required, label each volume as "Volume _____ of _____".
 - c. Name, address and telephone number of Contractor and Sub-Contractors including night or emergency number.
 3. Manual shall include, but shall not be limited to, the following:
 - a. A Complete Index. Contractor may submit the index to the Owner/Engineer for review prior to submittal of complete manuals if desired.
 - b. Names, Addresses and Telephone Numbers. This list shall include the manufacturer and local representative who stocks or furnishes repair parts for all items of equipment and shall be typed on a single page in front of the binder.
 - c. Startup, Operation and Shutdown Procedures. Provide a written description of procedures for startup, operation and shutdown of each electrical item or system. This description shall include switches to

operate, buttons to push, etc., in proper sequence, and the location of switches, starters, and pushbuttons. Description shall include item references or labels used in the contract documents unless otherwise instructed in advance by the Owner.

- d. Equipment Accessory Schedule. Upon completion of the work, furnish the Owner with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required and the manufacturer of renewable items.
- e. Manufacturer's Operation and Maintenance Manuals and Parts Lists.
- f. Emergency Procedures. Provide a written description of emergency operating procedures or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency services to the various parts of the system.
- g. One copy of shop drawings and product data, clearly marked for each item furnished using the designation label specified or indicated on Drawings.
- h. Manufacturers' warranty information.
- i. Normal Maintenance Schedule. Include a listing of work to be performed at various time intervals; i.e., 30, 90, 180 days and yearly.

1.12 OPERATING TRAINING

- A. Complete operating instructions for each system and item of equipment shall be provided to the Owner's designated personnel.
- B. Operation and Maintenance Manuals must be reviewed and accepted by the Owner/Engineer and provided to the Owner prior to operating training.
- C. Training shall be scheduled at the convenience of the Owner. A minimum of 4 hours of training shall be provided.
- D. Training shall include instructions on the following:
 - 1. Startup and shutdown procedures
 - 2. Periodic maintenance
 - 3. Emergency operation
 - 4. Safety
- E. In addition to the instructions required above, wherever possible perform the operations being described in order to fully illustrate system operation.
- F. At the completion of training, turn over to the Owner required keys and special tools for installed equipment. Each key or tool shall be labeled with its use.

1.13 QUALITY ASSURANCE

- A. Conform to the requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.14 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. 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.
 - C. 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.
 - D. 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.
 - E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
 - F. Coordinate electrical testing of electrical, mechanical, or architectural items so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
 - G. Provide offsets and elevation changes in conduit and cable tray as required to complete the Layout and Coordination Process.

1.15 STRUCTURAL COORDINATION

- A. In cases where the Contractor determines that superimposed loads such as suspended or floor mounted electrical system or equipment exist which exceed design loads indicated on structural contract documents, Contractor shall submit load data to Owner/Engineer for review prior to proceeding with work.
- B. Distribute the maximum load hung from any structural member for mechanical, electrical, plumbing, ductwork, piping, etc. over the member's tributary area in a way that the design superimposed dead loads listed in structural contract documents are not exceeded. The Contractor shall coordinate the loads and provide additional support or distribution framing as required achieving the allowable load distribution.
- C. Connections of systems designed by Contractor's engineer such as, but not limited to mechanical, electrical, plumbing loads are assumed to impose vertical and/or horizontal loads on the base building structural members without generating torsion in the supporting structural members. Contractor is responsible for furnishing and installing all supplementary bracing members as required to prevent torsion on the base building structure.

PART 2 PRODUCTS

2.1 PERFORMANCE, CAPACITIES AND CHARACTERISTICS

- A. See Drawings for Equipment Schedules for Equipment Performance Requirements when capacities and characteristics are not indicated in the specifications.

2.2 EQUIPMENT SHORT CIRCUIT CURRENT RATING

- A. Where the National Electrical Code or applicable codes require equipment to be marked with a Short Circuit Current Rating (SCCR), the equipment shall be manufactured as required such that the SCCR of the equipment meets or exceeds the available short circuit current at the equipment. Acceptable methods of complying with this requirement are as follows:
1. Provide SCCR rating at the equipment that meets or exceeds the available short circuit current at the switchboard or panelboard where the equipment circuit originates.
 2. Provide calculations, based on the available short circuit current at the switchboard or panelboard where the equipment circuit originates, that document the actual short circuit current available at the equipment. The SCCR rating of the equipment shall meet or exceed this calculated value.

2.3 MATERIALS

- A. Unless otherwise specified, all materials and equipment shall be new, unused and undamaged. Materials and equipment shall be the current and standard designs of manufacturers regularly engaged in their production.

2.4 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

- A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details and requirements.

2.5 QUANTITY OF SPECIFIED ITEMS REQUIRED

- A. Wherever in these specifications an article, device or piece of equipment is referred to in the singular number; such reference shall apply to as many such articles as are shown on the drawings or required to complete the installation.

PART 3 EXECUTION

3.1 GENERAL

- A. Fabrication, erection, and installation of the complete electrical system shall be done by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up the progress of the project.
- B. Check areas and surfaces where electrical equipment or materials are to be installed and report any unsatisfactory conditions before starting work.
- C. Commencement of work signifies the Contractor's acceptance of the conditions as fit and proper for the execution of the electrical work.
- D. Install equipment and systems in accordance with manufacturer's instructions, requirements, or recommendations.
- E. Comply with NECA 1.
- F. Unless otherwise noted, measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- G. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

- H. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- I. Right of Way: Give to raceways and piping systems installed at a required slope.
- J. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 DELIVERY AND STORAGE OF MATERIALS

- A. Make provisions for the delivery and safe storage of materials. Make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.
- B. Materials shall be delivered at such stages of the work as will expedite the work as a whole and shall be marked and stored in such a way as to be easily checked and inspected.
- C. Adequately protect supplies and equipment during cold weather.
- D. Protect items subject to cold weather damage by covering, insulating, or storing in a heated space.

3.3 COOPERATION WITH OTHER CONTRACTORS

- A. Perform the electrical work in conformance with the construction called for by other trades and afford other contractors reasonable opportunity for the execution of their work.
- B. Properly connect and coordinate the electrical work with the work of other contractors at such time and in such a manner as not to delay or interfere with their work.
- C. Examine the contract documents for the General, Mechanical, and Electrical work and the work of other trades. Coordinate work accordingly.
- D. Promptly report to the Owner/Engineer any delay or difficulties encountered in the installation of the electrical work which might prevent prompt and proper installation of work required from other trades.

3.4 COORDINATION OF WORK

- A. Plan work so it proceeds with a minimum of interference with other trades.
- B. Inform the General Contractor of all openings required in the building construction for the installation of the electrical work.
- C. Cooperate with other contractors in furnishing material and information, in proper sequence, for the correct location of sleeves, inserts, foundations, wiring, etc.
- D. Make provisions for special frames, openings, and sleeves as required.
- E. The Electrical Contractor shall pay for extra cutting and patching made necessary by his failure to properly direct such work at the correct time.

3.5 LAYING OUT WORK

- A. Carefully lay out work in advance of installation using data and measurements from the site, the appropriate civil, architectural, and structural drawings, and shop drawings.
- B. Confirm code required clearances.

- C. Do not infringe upon space required for operation, maintenance, or clearance for items installed by other contractors.
- D. Prior to installation of any work, make certain the location does not conflict with other items in or near the same location.
- E. If the layouts so prepared indicate that the required conditions cannot be met in the space provided, inform the Owner/Engineer prior to installation and request clarification.
- F. Failure to properly coordinate and lay out work will require correction by the Contractor at the Contractor's expense

3.6 DATA AND MEASUREMENTS

- A. Mechanical and Electrical drawings are diagrammatic or schematic. Do not scale drawings.
- B. The data given herein and on the drawings is as accurate as could be secured; absolute accuracy is not guaranteed.
- C. Obtain exact locations, measurements, levels, etc., at the site and adapt their work to actual conditions.
- D. Examine the General Construction, Mechanical, Electrical, and other applicable drawings and the Specifications.
- E. Utilize only Architectural drawings, Structural drawings, and site measurements in calculations.
- F. Layout and coordinate work prior to installation to provide clearances for operation, maintenance and codes. Verify non-interference with other work.
- G. Locate outlets and devices mounted on finished surfaces with regard to paneling, furring, trim, etc.
- H. Install outlets and devices with vertical edges of plates plumb.
- I. Install boxes or plaster rings such that the front edge extends to the finished surface of the wall, ceiling or floor without projecting beyond the surface.
- J. Install receptacles, switches, etc., on wood trim, cases, or other fixtures symmetrically and, where necessary, install with the long dimension of the plate horizontal.
- K. Coordinate locations of outlets and devices with other contractors so as not to destroy the aesthetic effect of the surface in which the outlets and devices are mounted. Coordinate the locations of electrical items with work furnished by other trades to avoid interference.
- L. Heights of outlets are measured from finished floor to centerline of device.
- M. Adjust heights as necessary to clear wall-mounted cabinets, fin tube convectors, unit heaters, etc.
- N. Mounting heights shall be in compliance with ADA requirements.
- O. Install outlets at the heights indicated below unless otherwise noted.
 - 1. Wall switches: 46 inches.
 - 2. Receptacle outlets (general): 18 inches.
 - 3. Receptacle outlets (kitchen, utility room, workbenches, etc.): 46 inches.

- P. The mounting heights of disconnect switches, circuit breakers, motor controllers, pushbutton stations and other similar devices and equipment may vary depending upon location and whether individually or group mounted.
- Q. For convenience and safety, mount equipment with the center of operating levers, handles or buttons no more than 72 inches above the finished floor.
- R. Locate individual devices or pieces of equipment, unless otherwise specified, so the operating handle, lever or button is located approximately 5 feet above finished floor. Coordinate heights of electrical items with work furnished by other trades to avoid interferences.
- S. Improperly located devices or outlets shall be relocated by the Contractor at the Contractor's expense including necessary patching.

3.7 PROTECTION OF APPARATUS

- A. Take necessary precautions to properly protect apparatus, fixtures, appliances, material, equipment, and installations from damage.
- B. Failure to provide such protection to the satisfaction of the Owner/Engineer shall be sufficient cause for the rejection of any particular piece(s) of material, apparatus, equipment, etc., concerned.

3.8 FIRESTOPPING

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

3.9 WORK IN EXISTING BUILDINGS

- A. Execute work in the existing building, indicated on the drawings or specified herein, with a minimum amount of interference with the normal activities of the occupants of the building.
- B. Schedule work in advance with the Owner and proceed only with the Owner's written approval.
- C. Utilities:
 1. Do not interrupt utilities without the Owner's prior written approval regarding the time and duration of such interruptions.
 2. Do not disconnect utilities to existing facilities until new or temporary facilities are installed except for short periods of interruption which are necessary for the performance of the new work and which are approved by the Owner.
 3. Storm water may be temporarily diverted to surface drainage provided such drainage is arranged to prevent flooding of structures, basements and excavations for construction.
- D. Fire Alarm System:
 1. As a minimum, maintain the existing degree of protection for all areas throughout construction.
 2. Coordinate required outages with the Owner and the Fire Marshal.
 3. After any additions or modifications to the fire alarm system, a re-acceptance test shall be performed by a licensed party in accordance with NFPA 72.
- E. Welding:
 1. Notify the Owner before starting welding or cutting.
 2. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc.

3. Stop operations involving welding or cutting with an open flame or arc not less than one hour before leaving the premises.
- F. Noisy Operations:
1. Schedule noisy operations, such as those involving use of air hammers, etc., in demolition or cutting of openings, with the Owner.
- G. Occupancy:
1. The Owner will continue to occupy the building and carry on normal activity.
 2. Protect the occupied areas from dust, smoke, etc., by a method reviewed by the Owner/Engineer.
- H. Owner's Right to Direct Work: The Owner shall have the right to direct the places of beginning work, its prosecution, and the manner in which all work under this contract is to be conducted, insofar as may be necessary to secure the safe and proper progress and quality of the work.
- I. Existing Conduits or Electrical Equipment:
1. Remove or relocate, as required, or as directed by the Owner/Engineer, existing conduit or electrical equipment which would interfere with the proper installation of new work.
 2. Modify existing work in conformance with these specifications.
 3. Use the same materials as for new work unless otherwise specified.

3.10 DEMOLITION AND REMODEL

- A. Protect existing electrical equipment and installations indicated to remain.
- B. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- D. 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.
- E. Remove demolished material from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Remove existing lights, receptacles, switches, etc., indicated on plans or which are not indicated but must be removed to accommodate demolition or new remodeling.
- H. Where existing walls are indicated to be removed, disconnect power to electrical devices and associated appurtenances relating to the walls.
- I. Maintain circuit continuity up and down stream from removed outlets.
- J. Extend circuiting to up and downstream devices and reconnect as required.
- K. Where existing site lighting fixtures are removed, verify the routing of existing circuits. Maintain circuit continuity between existing fixtures which remain.
- L. In areas which are remodeled, replace existing wire with new wire. No existing wire is permitted to remain unless noted.
- M. Existing concealed conduit and boxes may be reused.

N. Verify existing conditions in field prior to bid date.

3.11 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations.

B. Perform cutting by skilled mechanics of trades involved.

C. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.

D. Install new fireproofing where existing firestopping has been disturbed.

E. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.12 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work. Repair as necessary.

3.13 CLEANING AND PROTECTION

A. Remove burrs, dirt, paint spots, and construction debris from electrical items.

B. Protect electrical items so that finishes are without damage or deterioration at time of Substantial Completion.

3.14 TEMPORARY POWER AND LIGHTING

A. Provide temporary power and lighting throughout the construction period for the use by all trades, Contractors and Sub-Contractors.

B. Temporary facilities shall be installed in compliance with applicable codes and in compliance with OSHA requirements.

C. Cost of temporary power used during construction, including the cost of setting and removing temporary service, shall be paid by the Contractor.

D. Where existing building electrical system is used to provide temporary power and lighting, energy costs shall be paid by the Owner.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.

1.2 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- H. NFPA 70 - National Electrical Code.
- I. UL 44 - Thermoset-Insulated Wires and Cables.
- J. UL 83 - Thermoplastic-Insulated Wires and Cables.
- K. UL 486A-486B - Wire Connectors.
- L. UL 486C - Splicing Wire Connectors.
- M. UL 486D - Sealed Wire Connector Systems.
- N. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

3. Notify Owner/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Minimum Conductor Size:
 1. Branch Circuits: 12 AWG.
 2. Control Circuits: 14 AWG.
- I. Conductor Color Coding:
 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.

- 3) Phase C: Blue.
- 4) Neutral/Grounded: White.
- c. Equipment Ground, All Systems: Green.
- d. For control circuits, comply with manufacturer's recommended color code.

2.2 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN, THHN/THWN-2, or XHHW-2, except as indicated below.
 - a. Installed Underground: Type XHHW-2 or THHN/THWN-2.

2.3 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- C. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
- D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- G. Mechanical Connectors: Provide bolted type or set-screw type.
- H. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.4 ACCESSORIES

- A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Circuiting Requirements:
 1. When circuit destination is indicated without specific routing, determine exact routing required.
 2. Install service and feeder conductors unspliced unless otherwise indicated.
 3. Arrange branch circuiting to minimize splices.
 4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than 6 #12 AWG current-carrying conductors in 1/2 inch conduit; 9 #12 AWG current-carrying conductors in 3/4 inch conduit.
 - b. Provide no more than 6 #10 AWG current-carrying conductors in 3/4 inch conduit; 9 #10 AWG current-carrying conductors in 1 inch conduit.
 - c. Provide no more than 4 #8 AWG current-carrying conductors in 3/4 inch conduit; 6 #8 AWG current-carrying conductors in 1 inch conduit; 9 #8 AWG current-carrying conductors in 1-1/4 inch conduit.
 7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
 - 1. Pull all conductors and cables together into raceway at same time.
 - 2. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 3. Use suitable wire pulling lubricant where necessary, except as below:
 - a. Do not use when lubricant is not recommended by the conductor manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Install conductors with a minimum of 6 inches of slack at each outlet.
- G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- I. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors or heat shrink tubing.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- K. Insulate ends of spare conductors using vinyl insulating electrical tape.
- L. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- M. Identify conductors and cables in accordance with Section 26 05 53.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements.

- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION

Exhibit F

Contract Provisions for Non-Federal Entity Contracts Under Federal Awards

All or part of this project shall be funded with federal funds. Any resulting contract from this RFP shall contain the following provisions, as applicable.

(A) Contracts for more than the simplified acquisition threshold, which is the inflation adjusted amount determined by the Civilian Agency Acquisition Council and the Defense Acquisition Regulations Council (Councils) as authorized by 41 U.S.C. 1908, must address administrative, contractual, or legal remedies in instances where contractors violate or breach contract terms, and provide for such sanctions and penalties as appropriate.

(B) All contracts in excess of \$10,000 must address termination for cause and for convenience by the non-Federal entity including the manner by which it will be effected and the basis for settlement.

(C) Equal Employment Opportunity. Except as otherwise provided under 41 CFR Part 60, all contracts that meet the definition of “federally assisted construction contract” in 41 CFR Part 60-1.3 must include the equal opportunity clause provided under 41 CFR 60-1.4(b), in accordance with Executive Order 11246, “Equal Employment Opportunity” (30 FR 12319, 12935, 3 CFR Part, 1964-1965 Comp., p. 339), as amended by Executive Order 11375, “Amending Executive Order 11246 Relating to Equal Employment Opportunity,” and implementing regulations at 41 CFR part 60, “Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor.”

(D) Davis-Bacon Act, as amended (40 U.S.C. 3141-3148). When required by Federal program legislation, all prime construction contracts in excess of \$2,000 awarded by non-Federal entities must include a provision for compliance with the Davis-Bacon Act (40 U.S.C. 3141-3144, and 3146-3148) as supplemented by Department of Labor regulations (29 CFR Part 5, “Labor Standards Provisions Applicable to Contracts Covering Federally Financed and Assisted Construction”). In accordance with the statute, contractors must be required to pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in a wage determination made by the Secretary of Labor. In addition, contractors must be required to pay wages not less than once a week. The non-Federal entity must place a copy of the current prevailing wage determination issued by the Department of Labor in each solicitation. The decision to award a contract or subcontract must be conditioned upon the acceptance of the wage determination. The non-Federal entity must report all suspected or reported violations to the Federal awarding agency. The contracts must also include a provision for compliance with the Copeland “Anti-Kickback” Act (40 U.S.C. 3145), as supplemented by Department of Labor regulations (29 CFR Part 3, “Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States”). The Act provides that each contractor or subrecipient must be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled. The non-Federal entity must report all suspected or reported violations to the Federal awarding agency.

(E) Contract Work Hours and Safety Standards Act (40 U.S.C. 3701-3708). Where applicable, all contracts awarded by the non-Federal entity in excess of \$100,000 that involve the employment of mechanics or laborers must include a provision for compliance with 40 U.S.C. 3702 and 3704, as supplemented by Department of Labor regulations (29 CFR Part 5). Under 40 U.S.C. 3702 of the Act, each contractor must be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 U.S.C. 3704 are applicable to construction work and provide that no laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

(F) Rights to Inventions Made Under a Contract or Agreement. If the Federal award meets the definition of “funding agreement” under 37 CFR § 401.2 (a) and the recipient or subrecipient wishes to enter into a contract with a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance of experimental, developmental, or research work under that “funding agreement,” the recipient or subrecipient must comply with the requirements of 37 CFR Part 401, “Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements,” and any implementing regulations issued by the awarding agency.

(G) Clean Air Act (42 U.S.C. 7401-7671q.) and the Federal Water Pollution Control Act (33 U.S.C. 1251-1387), as amended - Contracts and subgrants of amounts in excess of \$150,000 must contain a provision that requires the non-Federal award to agree to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251-1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

(H) Debarment and Suspension (Executive Orders 12549 and 12689) - A contract award (see 2 CFR 180.220) must not be made to parties listed on the governmentwide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 1989 Comp., p. 235), “Debarment and Suspension.” SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared ineligible under statutory or regulatory authority other than Executive Order 12549.

(I) Byrd Anti-Lobbying Amendment (31 U.S.C. 1352) - Contractors that apply or bid for an award exceeding \$100,000 must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier must also disclose any lobbying with non-Federal funds that takes place in

connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the non-Federal award.

Certification Regarding Lobbying

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

(J) See 2 CFR § 200.323. A non-Federal entity that is a state agency or agency of a political subdivision of a state and its contractors must comply with section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds \$10,000 or the value of the quantity acquired during the preceding fiscal year exceeded \$10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery; and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.

(K) Contractor shall comply with 2 CFR § 200.216, as applicable.

(L) Contractor shall comply with 2 CFR § 200.322, as applicable.

Record Keeping

Contractor certifies that it will comply with all records retention and access responsibilities detailed in 2 CFR 200.334 – 2 CFR 200.338.